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Structural & Thermal Investigation Studies of Synthesized Cerium Doped Akermanite Phosphor

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Abstract:
Here, we reported that the TL characteristics of rare earth Ce doped $Ca_2MgSi_2O_7$ phosphor using conventional high temperature solid-state reaction technique at the constant furnace temperature 1200^0C. It was further characterized by XRD (x-ray diffraction), for confirmation of phase purity, and also characterized by Thermoluminescence reader for thermal properties. The synthesized material has shown tetragonal crystal structure with single phase. We have observed the TL glow curve situated at 131.25^0C which reveals that the TL intensity is maximum for 15 minutes UV-irradiation time for Ce dopant ions. The synthesized phosphor displays potential application as a long persistent phosphor as well as better TL material.

Keywords: X-ray diffraction (XRD), Solid-State Reaction, $Ca_2MgSi_2O_7:Ce^{3+}$, Thermo-luminescence (TL).

INTRODUCTION

Each day, technological advances at an astounding pace that may people find consider beyond understanding. Research in the material sciences has risen in the modern era of technological advancements. The level of competition as well as curiosity is rising as increasing investigators and researchers endeavour to broaden and develop novel concepts related to societal benefits and environment protection. We are to demonstrate that the most rapid growing domains of material science as a luminescent tool to great support for efficient technologies. In modern times, every aspect of technological advancement in these fields such as search for novel thermoluminescent material and long persistent phosphor applications indicate the fast track towards achievement. An intriguing and significant role for long persistent materials is played in the rapid development of the lighting industries and technologies.

Mellites are a diverse group of substances with a typical structural formula: $A_2X^1Y_2^2O_7$ [where A = Ba, Sr, Ca; X^1 = Mg, Zn, Cu, Mn, Co; and Y^2 =Ge, Si] [1]. Different rare earth doped $Ca_2MgSi_2O_7$ was prepared by solid-state reaction technique under weak reduction atmosphere [2]. $Ca_2MgSi_2O_7$ phosphor have been broadly investigated from the manufacturing purpose because it is clearly indicating to better qualities of product sample, stability, energy consumed, abundant and relatively inexpensive [3,19]. Over the last 15 years, silicate-based rare earth (RE)-ion-doped phosphors have attracted a great deal of interest [4] because of their excellent properties, e.g., high thermal and chemical stability in natural surroundings, cheaper, excellent water resistance and strong absorption in the near UV region [5] high brightness, long persistency, non-toxic and environmental capability. Ce^{3+} ions are expected to substitute Ca^{2+} lattice site in the host crystal lattice ($Ca_2MgSi_2O_7$) because the ionic radii of Ce^{3+} and Ca^{2+} ions are 1.034Å and 1.12Å, respectively, and match closely. Ce^{3+} does not replace Mg^{2+} and Si^{4+} ions because the ionic radius

of Mg^{2+} (0.89Å) & Si^{4+} (0.40Å) are far smaller than that of Ce^{3+} ions [6]. Cerium [Ce^{3+}] rare-earth ions could not only be trap centre but also perform as luminescence-centre. In this present work, the result of XRD study, this phosphor revealed its tetragonal, akermanite structure with a space group $P\bar{4}2_1m$. In this TL study, the sample exposed for 15minutes produces the best TL intensity at 131.25°C temperature and exhibits a single TL glow curve peak. The synthesized $Ca_2MgSi_2O_7: Ce^{3+}$ (CMS: Ce) phosphor is a more effective and superior TL phosphor for long persistent applications. In this work, high temperature solid state reaction technique was used to prepare CMS: Ce phosphor using H_3BO_3 as a flux. The structural property of CMS: Ce powder sample was characterized by powder X-ray diffraction (XRD) and thermal property was also performed on the basis of thermo-luminescence (TL) glow curve peak.

EXPERIMENTAL PROCEDURE

Solid-State Synthesis

Traditionally, phosphors are synthesized in powder form by different procedures involving crushing, grinding, ball milling, sol-gel, microwave process, combustion synthesis, co-precipitation and high temperature conventional solid-state reactions, Thermal decomposition and Flame synthesis technique etc. Among these methods, the most popular method is solid state reaction technique. This method has shown their potential as an important route for material synthesis, because sample prepared using this technique have good luminescence and very better morphology also. This technique can provide superior luminescent intensity and better long-persistent features in comparison of the same phosphor synthesized via other synthesis techniques.

Material Synthesis

The $Ca_2MgSi_2O_7: Ce^{3+}$ sample was prepared by conventional high temperature solid-state reaction technique. The initial chemical reagents were utilized as $CaCO_3$ (99.99%), MgO (99.99%), $SiO_2.H_2O$ (99.99%) and rare earth oxide CeO_2 (99.99%) and boric acid (H_3BO_3) was also utilized as a flux in very small quantity. The raw chemical reagents were weight stoichiometrically and mixed thoroughly grind in an agate mortar pestle, then sintered under a weak reducing atmosphere (i.e., using activated charcoal) at 1200°C for approximately 3.30 hours after being held in a programmable muffle furnace. The furnace's heating and cooling rates were both set at 5°C per minute. Additional grinding, which produces fine powder, was used to create the final $Ca_2MgSi_2O_7: Ce^{3+}$ phosphor. For further characterization study, the synthesized phosphor was placed in a sealed container.

The reagents' chemical reaction is,

$$2CaCO_3 + MgO + 2SiO_2.H_2O + CeO_2 \rightarrow Ca_2MgSi_2O_7: Ce + 2H_2O\,(\uparrow) + 2CO_2\,(\uparrow) + O_2\,(\uparrow) \quad (1)$$

Material Characterization

Samples are weighed using Shimadzu ATX 224 single pan analytical balance and the samples are synthesized in a high temperature digital muffle furnace. The crystalline structure, size and phase composition of the sample are examined by Bruker D8 advanced X-ray diffractometer and $Cu - K_\alpha$ radiation with a wavelength of (λ =1.5405 Å), where X-rays are generated and operated at 40KV/40mA voltage and current values respectively. The TL spectra are recorded using Nucleonics make TL reader (model I 10091). All tests were carried out under the same conditions, and it was found that the outcomes were repeatable. Every measurement was made at room

temperature.

RESULT AND DISCUSSIONS

X-Ray Diffraction (XRD) Analysis

This material characterization technique was widely utilized to identify the phase composition, structure and their crystallinity. In Fig.1, the XRD-pattern of synthesized $Ca_2MgSi_2O_7$: Ce^{3+} phosphor have well matched from standard JCPDS data file (#77-1149) [7]. The XRD pattern were collected in the range of 10°<2θ<60°.

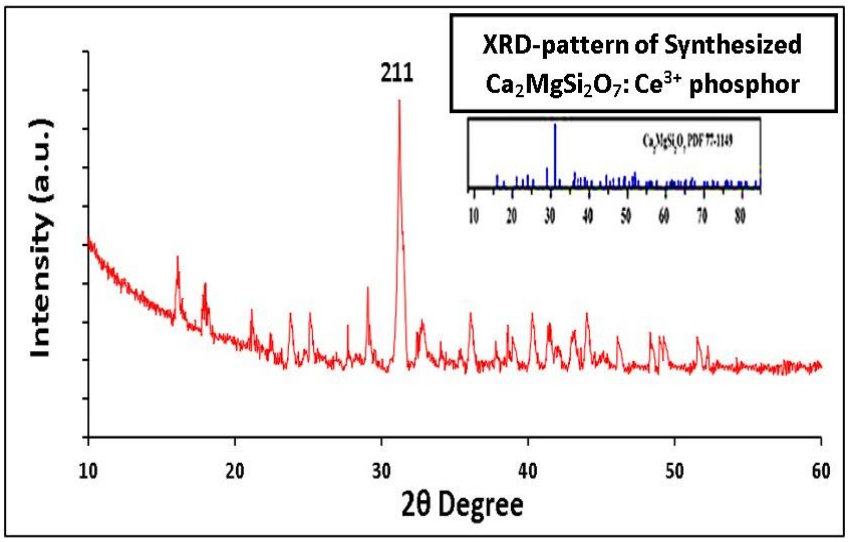

Figure 1: XRD-pattern of synthesized $Ca_2MgSi_2O_7$: Ce^{3+} phosphor

The layered compound formed by this crystal structure, which belongs to the melilite group. The cell parameters were a = b = 7.8071 Å, c = 4.9821 Å & α = β = γ = 90° [8]. Therefore, Cerium [Ce^{3+}] ions have expected to occupy the Ca^{2+} sites in the host. We note that the structure of this phosphor was not altered by the addition of rare earth doped ions. The doped Ce^{3+} ions did not change significantly the lattice structure of the host. XRD analysis also confirmed the produced phosphors' phase development. Here, the phase structure of the synthesized sample are exhibits akermanite type structure which belongs to the tetragonal crystal symmetry with space group $P\bar{4}2_1m$.

Crystallite/Particle Size (D) & Crystal Lattice Strain (ε)

The crystallite size (D) of the synthesized $Ca_2MgSi_2O_7$: Ce^{3+} phosphor is calculated as 44.26 nm, for (211) peak using Debye-Sherrer equation. Debye–Scherrer formula [9] is represented as: $D = k\lambda/\beta Cos\vartheta$. The crystal lattice strain of the synthesized $Ca_2MgSi_2O_7$: Ce^{3+} phosphor is calculated as 0.28nm. The crystal lattice strain induced broadening in the powder material were calculated via the following mathematical relation as: $\varepsilon = \beta/4tan\vartheta$. Where K is the Scherrer constant having value 0.94, k is wavelength of incident X-ray, β is the FWHM of the peaks and θ is the corresponding Bragg's diffraction angle as well as **ε** is the crystal lattice strain.

Thermoluminescence (TL) Analysis

Thermo-luminescence (TL) is the phenomenon of light emission upon heating a material, which has been previously excited. All types of radiations, such as gamma rays, X-rays, alpha rays, beta rays and light rays can 'excite' a material, but to widely different extents [10]. The long afterglow characteristics of thermo-luminescence phosphor, also known as persistent luminescence, are

extremely useful in a variety of applications, including emergency signs, bio- imaging, and brightness on dark roads. The development of novel TL materials demonstrates a brand-new and rapidly expanding field of application for research in the fields of physics, medicine, mineral production, archaeological dating, forensic science, and radiation dosimetry [11].

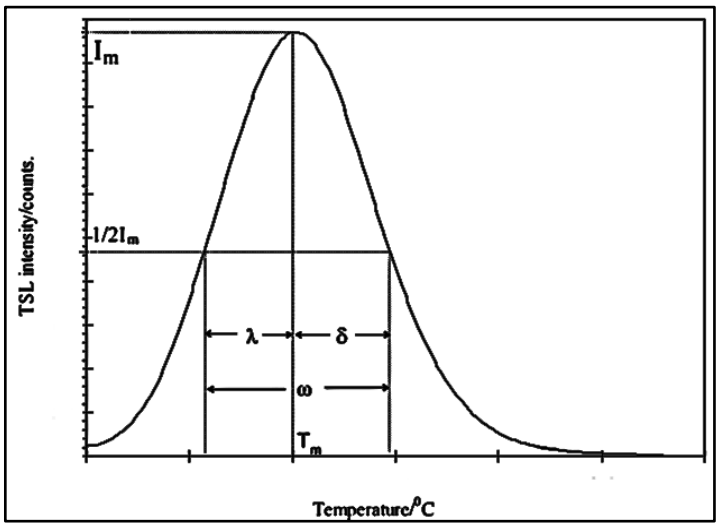

Figure 2: An illustration of a typical thermoluminescent light curve utilizing the peak shape approach.

Calculation of Kinetic Parameters

The TL glow peaks is highly isolated from the others, the experimental technique such as peak shape method [Fig.2] is appropriate to determine kinetic parameters. The TL kinetic parameters such as activation energy [E], order of kinetics [b], and frequency factor [S] for the prominent glow peak of sintered phosphors were calculated with the help the peak shape method. In order to determine the kinetic parameters of TL glow curves, Chen's empirical formula was used. It is clearly depending on the peak shape of TL glow curve [12].

Fig. 3 shows the TL glow curve of $Ca_2MgSi_2O_7: Ce^{3+}$ phosphor for fixed 15min UV radiation times. In the present case, the TL intensity increases with increasing irradiation time up to 15min and then decreases over time because, at a particular time, the population of trapped charge carriers in a metastable state reaches a maximum value. From the TL glow curve of synthesized $Ca_2MgSi_2O_7: Ce^{3+}$ phosphor, it was observed that single broad peak exists at 131.25°C temperature. The mechanism of recombination of de-trapped charge carriers with their counterparts is called as the order of kinetics [b]. The order of kinetics for glow peak of $Ca_2MgSi_2O_7: Ce^{3+}$ phosphor can be determined via calculating geometrical factor μ_g from the mathematical relation as follows:

$$\mu_g = \frac{\delta}{\omega} = \frac{T_2 - T_m}{T_2 - T_1} \quad (2)$$

where T_m is the optimum peak temperature, T_1 and T_2 are temperatures at half intensity on the ascending and descending parts of the glow peak, respectively, [$\omega = T_2 - T_1$], the high temperature half width [$\delta = T_2 - T_m$] maxima (FWHM). The geometric factor is to differentiate between first and second order TL glow peak. [μ_g = 0.39-0.42] for the first order kinetics; [μ_g = 0.49-0.52] for the second order kinetics and [μ_g = 0.43-0.48] for the mixed order kinetics [13-15].

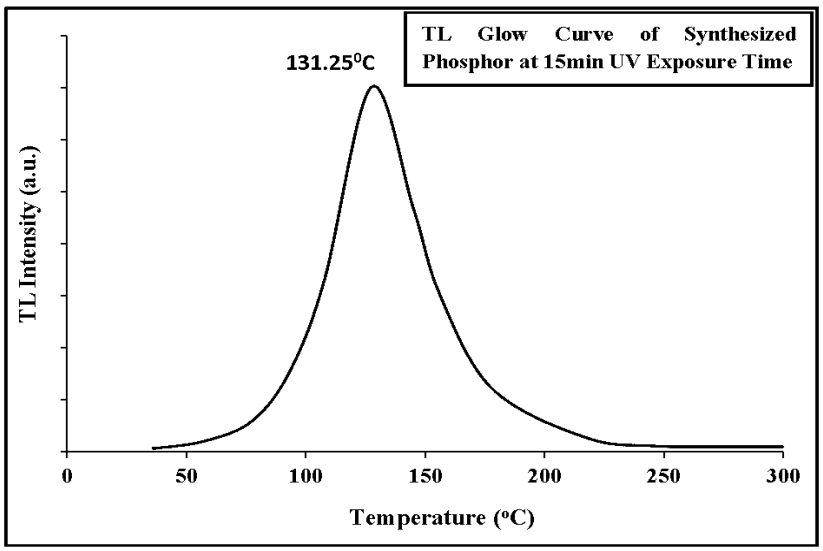

Figure 3: TL glow curve of synthesized $Ca_2MgSi_2O_7$: Ce^{3+} phosphor

The μ_g of the single peak was calculated and found to be 0.49, respectively, which are close to the value for the second-order peak (0.49-0.52). This shows that the single band is second-order peak. The result indicates that, after the carriers from the traps corresponding to the band was released, the probability of retrapping carriers is increased in comparison with that of the first-order case [14].

We used the following equation to estimate the depth of the traps, E:

$$E_\alpha = C_\alpha \left(\frac{kT_m^2}{\alpha}\right) - b_\alpha(2kT_m) \quad (3)$$

where k is the Boltzmann constant. The relationship between the frequency factor s and the depth E of the trap is given by

$$\frac{\beta E}{kT_m^2} = s\left[1 + (b-1)\frac{2kT_m}{E}\right]\exp\left(-E/kT_m\right) \quad (4)$$

where β is the heating rate, b is the order of the kinetics, which is 2 in this case. The trap parameters of depth E, and frequency factor S at the temperature of room temperature are given in the Table 1, calculated according to eqns 2–4.

Table 1: TL kinetic parameters of Synthesized $Ca_2MgSi_2O_7$: Ce^{3+} Phosphor

UV Exposure Time	Peak temperature T_m/°C	Trap Depth E(eV)	Frequency factor (S/s)
15min	131.25	0.66	3.80×10^{10}

Fig 3. represent that the effect of 15min UV exposures on the $Ca_2MgSi_2O_7$: Ce^{3+} phosphor and all TL parameters are calculated in Table 1. Corresponding the Activation Energy (E) and Frequency factor (s^{-1}) were calculated is 0.66eV and $3.80\times10^{10}s^{-1}$ respectively. Trap depth/Activation energy calculated as 0.66eV, which supports the fact that the sample show higher amount of persistency in its thermoluminescence property [15]. Sakai et al. and Mashangva et al. were reported that an appropriate trap depth (0.65-0.75 eV) is necessary for materials to display long persistence characteristics [16,17]. So, the trap density of synthesized materials is

appropriate for long afterglow properties. In our case of phosphor, the activation energy is found 0.66eV respectively, which indicates that a better long persistency and superior thermoluminescent intensity. It is highly favorable properties for application as long persistency.

CONCLUSIONS

$Ca_2MgSi_2O_7: Ce^{3+}$ phosphor was well synthesized using the conventional high temperature solid-state reaction technique under a weak reducing atmosphere (i.e., using activated charcoal). Crystal phase structure was identified by XRD and the thermal properties were investigated by TL reader. The XRD analysis revealed that the compound is single crystalline phase $Ca_2MgSi_2O_7: Ce^{3+}$ phosphor with tetragonal, akermanite structure with a $P\bar{4}2_1m$ phase group, which is confirmed through JCPDS #77-1149. The particle size of synthesized phosphor varies between 35 and 52 nm with an average value of 44.26 nm and crystal lattice strain is calculated as 0.28nm. In TL analysis, single broadband glow curve peak was observed at 131.25°C. It is very clear from TL spectra that second order kinetics, which supports the probability of re-trapping released charge carriers before recombination process. The value of the activation energy or trap-depth was found to be 0.66eV. Thus, it is concluded that this phosphor exhibits excellent thermal stability, indicating that it is highly favourable properties for application as long persistent properties and as a better TL material.

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Assessment of Noise Level from Selected Highways and Motor Parks in the Federal Capital Territory (FCT) Abuja

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Abstract:
This study determined the noise level of specifically selected Highways and Moto parks in the Federal Capital Territory (FCT) Abuja Nigeria, as compared with the regulatory permissible limit for noise exposure. These sources were studied at five specific locations each. A total of 10 locations were studied. Noise level was determined using the Noise Level Meter App (18.0). The minimum, maximum and average noise readings displayed on the noise meter were recorded at 4 sampling points per location. Readings were taken in the morning (7-10am), afternoon (12 noon-2 pm) and evening (5-7pm) per sampling point. Data were analyzed using Minitab 17.0. One Way ANOVA (Analysis of Variance) was applied while mean separation was done using the Fisher's method at P≤0.05 (95% confidence limit). The DNLs (Daytime Noise Level) of highways was 81.5 dB while motor park was 76.1 dB. All noise level parameters exceeded NESREA permissible limits of 65 dB limits and the WHO limit of 75 dB. Significant differences were recorded in noise levels readings at different periods of time (P<0.05) where morning (AMNL) and afternoon (AANL) readings were significantly higher than the evening (AENL) reading. Although nighttime noise level (NNL) was within the acceptable range, the NNL were higher at all motor parks including El-Rufai Park Nyanya (50.2 dB), Benue Links Park Area 1 Graki (49.6 dB), Pleasure Travels Park Mararaba (49.5 dB). Trees were either absent or low in density at motor parks but were in abundantly present at highways. This study found no relationship between noise level and presence of trees at designated places as R-values were very weak. There is need to apply appropriate noise reduction mechanism in the FCT as the seat of the Federal Government since the regulatory limits are exceeded. There is need for appropriate noise regulatory measures by relevant stakeholders in the environmental and health sectors.

Keywords: Noise Level, FCT, Highway, Motor parks, Regulation

INTRODUCTION

Noise pollution is an extensive environmental issue that affects millions of people worldwide (Gupta *et al.*, 2018). It refers to the excessive or disturbing noise that disrupts the normal functioning of human activities and has detrimental effects on physical and psychological well-being (Bragdon, 2016). Noise pollution can arise from various sources, including transportation systems, industrial activities, construction sites, and recreational activities. The increasing urbanization and industrialization of societies have amplified the problem, making noise pollution a significant concern for public health and quality of life (Singh, 2020). Excessive exposure to noise pollution has numerous adverse effects on human health. Prolonged exposure to high noise levels can lead to hearing loss, sleep disturbances, and increased stress levels. It can also contribute to cardiovascular problems, such as hypertension and heart disease (Basner *et al.*, 2014). Noise pollution can impair concentration, hinder productivity, and affect cognitive performance in both

adults and children. Additionally, it can cause annoyance, irritability, and a reduced sense of well-being, impacting overall quality of life (Gupta *et al.,* 2018).

The noise pollution situation in the Federal Capital Territory (FCT) is similar to that in many urban areas. The city is relatively large, having rapid increase in population growth rate. The population the city has expanded continuously in all directions in the past two decades. Many significant changes have been experienced in terms of urbanization, industrialization, expansion of road-network, and infrastructure. The city has been subjected to persistent road traffic and commercial activities due to overall increase in prosperity, fast development, and expansion of the economy (Gadanya and Buhari, 2021). A study by Ibekwe *et al.* (2016) revealed a progressive encroachment and unauthorized conversion of many residential areas in Abuja into business outlets have had consequent increase in human and vehicular traffic.

The Federal Capital Territory Abuja is becoming expanded, heavily populated, and noisy. Major causes of noise pollution identified in many commercial cities are on the increase in the FCT due to urbanization and industrialization, not minding the nature of the Abuja Master Plan. There are increasing numbers of markets, motor parks, worship centers, vehicular movement, traffic congestion, mechanic villages and schools in the FCT. The volumes of noise generated by these sources have not been fully investigated in the study area. It is not certain if the noise levels have exceeded the permissible limits of the World Health Organization (WHO) and the National Environment Standards and Regulations Enforcement Agency (NESREA). This dearth of robust data may hinder appropriate control measures. Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories: physical effects (such as hearing defects), physiological effects (such as increased blood pressure, irregularity of heart rhythms and ulcers), psychological effects (such as disorders and sleeplessness, irritability and stress) and finally effects on work performance and productivity (Gadanya and Buhari, 2021). The aim of the present study was to assess the noise level generated at highways and motor parks in the Federal Capital Territory (FCT) Abuja and and compare to the permissible limit of the WHO and NESREA

MATERIALS AND METHODS

Study Area

The study was carried out in Abuja, the Federal Capital Territory (FCT) and its environs (10.44594^{0}N, 7.1811^{O}E) in North Central Nigeria. The study was carried from March to September 2023. The study area is the seat of Federal Government of Nigeria designed to accommodate government Ministries, Agencies, and Parastatals. The boundary States are Nasarawa, Niger, Kogi and Kaduna States. The FCT consists of six Area Councils: Abaji, AMAC, Bwari, Gwagwalada, Kuje, and Kwali (Abuja Geographic Information System -AGIS) The temperature ranged from 23.5^{o}C in the night to 39.2^{o}C during at daytime with an elevation of 273m above sea level. The map of the study area is shown in Figure 1.

Study Design

The study targeted two (2) potential sources of noises designated as: Highway and Motor parks. These sources were studied at five specific places chosen based on their potentials to generate noise within the study area. A total of 10 locations were studied. Coordinates were taken using the Coordinate Application downloaded from Google Play Store. Table 1 gives the description of the 10 locations of the 2 designated sources of noise including their codes and coordinates.

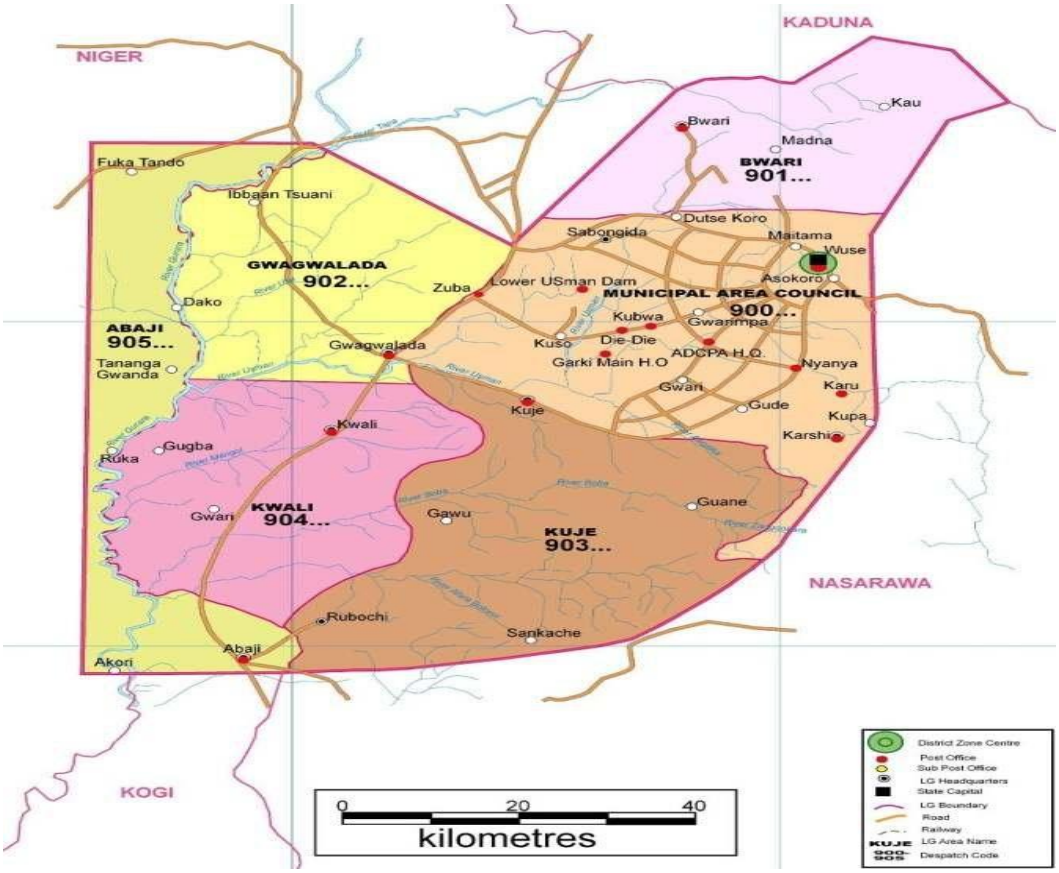

Figure 1: Map of the Study Area (Abuja Geographic Information System -AGIS)

Table 1: Study Locations and Coordinates

Designation	Code	Location	Coordinates
High Way-1	AHW-1	Shehu Shagari Way, Maitama	E-7.4952838/N-9.0704454
High Way-2	AHW-2	Olusegun Obasanjo Way, Wuye	E-7.469609/N-9.053600
High Way-3	AHW-3	Ibrahim Babangida Way, Wuse	E-7.484241/N-9.076242
High Way-4	AHW-4	Zuba-Kubwa Express Way	E-7.428019/N-9.304604
High Way-5	AHW-5	Murtala Mohammed Express Way	E-7.330934/N-9.142231
Motor Park-1	AMP-1	El-Rufai Park Nyanya	E-7.572863/N-9.004531
Motor Park-2	AMP-2	Jabi Motor Park- Jabi	E-7.423680/N-9.060280
Motor Park-3	AMP-3	Benue Links, Area 1, Garki	E-7.485015/N-9.033834
Motor Park-4	AMP-4	Zuba Motor Park, Zuba	E-7.087496/N-8.940141
Motor Park-5	AMP-5	Pleasure Travels Park, Mararaba	E-7.424033/N-10.445949

Noise Level Determination

Noise level was determined using the Noise Level Meter App (18.0) downloaded from the Google Play Store (Figure 3) into a Mini tablet (*Itel* android). The method of Ibekwe *et al.* (2016) was adopted where use of mobile phones noise level app was validated for environmental sound level measurement. Validation was further carried out through the use of three different android phone to obtain synchronous values. The phones were held 1.5 meters above ground levels at each sampling point for uniformity in measurements, Readings were taken from 4 sampling points at each location, 5 minutes per sampling point (Oyedepo *et al.*, 2019). Noise level was determined from a total of 140 points (7 designations x 5 places x 4 points). This is equivalent to 35 locations and 4 points per location. The minimum, maximum and average noise readings displayed on the noise meter were recorded at each sampling point. Daytime readings were taken for all

designated places in the morning (7-10am), afternoon (12 noon-3 pm) and evening (5-8pm) per sampling point (Oyedepo *et al.*, 2019). Nighttime (12- 2pm) readings were carried out. Data were collected from Monday-Saturday except at worship centers. In the latter, data were collected on Sunday only during church service in the morning/afternoon, evening and night because some church services extended into the afternoon session. Hence morning/afternoon was assessed together. Large crowded worship centers were targeted.

Noise Data Collection

The collected were entered into the field log book and transferred into the Microsoft Excel Workbook (Window 2010) for arrangements and computation of parameters. The following noise parameters were computed in decibels (dB): AMNL (Average Morning Noise Level), AANL (Average Afternoon Noise Level) and AENL (Average Evening Noise Level) The DNL (Daytime Noise Level) was computed as average of AMNL, AANL and AENL while MNLR (Maximum Noise Level Recorded) was recorded as the highest value of noise reading taken within 5 minutes at a location. Nighttime noise level (NNL) was taken as a single parameter

Data Analysis

Data were analyzed using Minitab 17.0. One Way ANOVA (Analysis of Variance) was applied while mean separation was done using the Fisher's method at P≤0.05 (95% confidence limit). Chi-Square distribution was computed to determine association between noise level and locations. Pearson's correlation analysis was applied to determine the relationship between noise level and tree density. Results were presented in tables, box plots and bar graphs. Noise level parameters were compared with regulatory permissible limits of exposure as given by WHO and NESREA.

RESULTS

Noise Level Parameters at Highways

Table 2 shows day time noise level parameters at 5 busy highways (AHW1- AHW5) in the FCT Abuja. The Average Morning Noise Level (AMNL) was 82.3 - 84.5 dB and all values were higher than the WHO and NESREA limits of 75 dB and 65 dB respectively. The Average Afternoon Noise Level (AANL) ranged from 81.1 to 82.5 dB, and all values were higher than the regulatory limits of exposure. The Average Evening Noise Level (AENL) readings were between 78.5-80.5 dB and were all found higher regulatory permissible limit. Significant differences were recorded in noise levels readings at different periods of time ($F=34.61$, $P<0.05$) where morning noise readings (83.2 dB) were significantly higher than afternoon (81.8 dB) and evening time (79.4 dB) (Figure 2). The Daytime Noise Level (DNL) readings ranged from 81.1 dB at AHW1 (Shehu Shagari Way, Maitama) to 82.0 dB at AHW3 (Ibrahim Babangida Way, Wuse). Results showed that DNL values were statistically the same at the five highways ($F= 0.10$, $P>0.05$) and were found higher than regulatory permissible limit. The highway locations had Maximum Noise Level (MNL) readings of 108.1 -186.6 dB above WHO and NESREA limits

Table 2: Day Time Noise Level Parameters along Highways in the FCT

High Way code	Location	AMNL dB	AANL dB	AENL dB	DNL dB	MNL dB	NNL dB	WHO PL dB	NESREA PL dB
AHW1	Shehu Shagari Way, Maitama	83.3	81.4	78.5	81.1[a]	186.6	NA	75	65
AHW2	Olusegun Obansanjo Way Wuye	82.6	81.6	79.4	81.2[a]	148.2	NA	75	65

AHW3	Ibrahim Babangida Way, Wuse	84.5	82.5	79.0	82.0[a]	108.1	NA	75	65
AHW4	Zuba-Kubwa Express Way	83.4	81.1	79.5	81.3[a]	129.0	NA	75	65
AHW5	Murtala Mohamed Express Way	82.3	82.3	80.5	81.7[a]	149.6	NA	75	65
		83.2[a]	81.8[b]	79.4[c]					

F (Daytime Noise Level Vs Locations) = 0.10, P= 0.979 (P>0.05)
F (Daytime Noise Level Vs Period) = 34.61, P= 0.000 (P<0.05)

Legend:
AHW= Abuja High Way
AMNL= Average Morning Noise Level
AANL= Average Afternoon Noise Level
AENL= Average Evening Noise Level
DNL= Daytime Noise Level
MNLR = Maximum Noise Level Recorded
PL= Permissible Limit

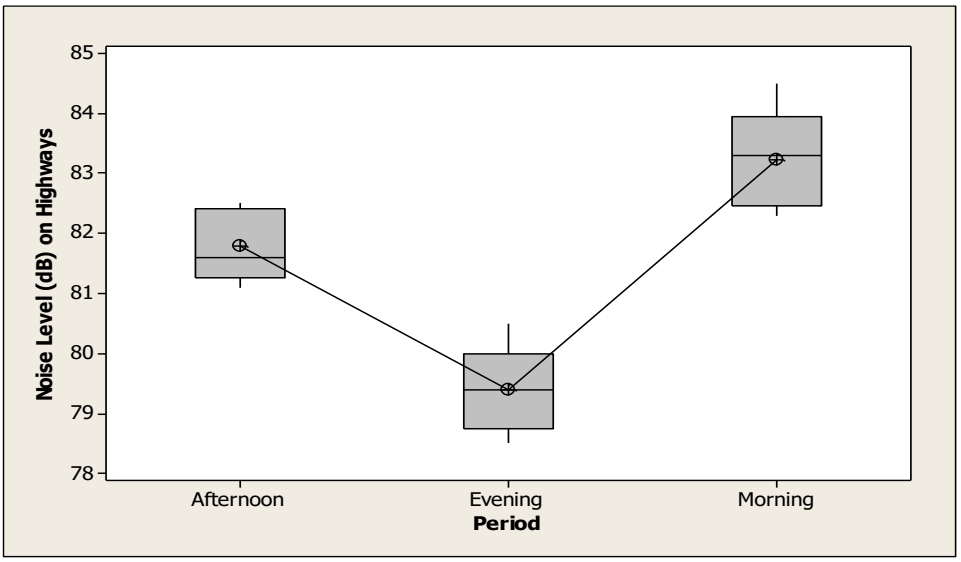

Figure 2: Box Plot of Periodic Noise Level at Highways in the FCT

Noise Level Parameters at Motor Parks

Table 3 gives the day time noise level parameters at 5 motor parks (AMP1- AMP5) in the FCT Abuja. The Average Morning Noise Level (AMNL) was 78.7 – 80.0 dB and all values were higher than the WHO (75 dB) and NESREA (65 dB) limits. The Average Afternoon Noise Level (AANL) ranged from 74.0 to 75.3 dB, and they were found above the NESREA (65 dB) limits and only AMP1 (the El-Rufai Park Nyanya) had its AANL above the WHO (75 dB) limit of exposure. The Average Evening Noise Level (AENL) readings were in the range of 72.7-76.3 dB and were all found above the NESREA (65 dB) limits while two parks (AMP1 and AMP2) had their AENLs higher than the 75 dB maximum limit as recommended by the WHO. Significant differences were recorded in noise levels readings at different periods of time (F=52.0, P<0.05) where morning noise readings (79.4 dB) were significantly higher than other periods, although the afternoon (74.4 dB) and evening noise levels (74.4 dB) were the same (Figure 3). The Daytime Noise Level (DNL) readings ranged from 75.4 dB at AMP-5 (Pleasure Travels Park Mararaba) to 77.1 dB at AMP1 (El-Rufai Park

Nyanya). Results showed that DNL values were statistically the same at the five motor parks (F= 0.17, P>0.05) and that values were found higher than the WHO (75 dB) and NESREA (65 dB) limits. The Maximum Noise Level (MNL) was at the highest peak at the El-Rufai Park Nyanya (183.8 dB) while the lowest MNL was recorded at Zuba Motor Park (91.3 dB). The recorded MNLs were above the regulatory limits of exposure. However, Nighttime Noise level (NNL) of 44.6-50.2 dB recorded at parks was below the permissible limit.

Table 3: Day Time Noise Level Parameters at Motor Parks in the FCT

Motor Parks code	Location	AMNL dB	AANL dB	AENL dB	DNL dB	MNL dB	NNL dB	WHO PL dB	NESREA PL dB
AMP-1	El-Rufai Park Nyanya	79.7	75.3	76.3	77.1[a]	183.8	50.2	75	65
AMP-2	Jabi Motor Park	80.0	74.2	75.1	76.4[a]	122.4	44.6	75	65
AMP-3	Benue Links Area 1, Garki	79.3	74.0	73.7	75.7[a]	130.2	49.6	75	65
AMP-4	Zuba Motor Park	78.7	74.4	74.0	75.7[a]	91.3	48.1	75	65
AMP-5	Pleasure Travels Park Mararaba	79.3	74.1	72.7	75.4[a]	109.1	49.5	75	65
		79.4[a]	74.4[b]	74.4[b]					

F (Daytime Noise Level Vs Locations) = 0.17, P= 0.949 (P>0.05)
F (Daytime Noise Level Vs Period) = 52.00, P= 0.000 (P<0.05)

Legend:
AMP= Abuja Motor Parks
AMNL= Average Morning Noise Level
AANL= Average Afternoon Noise Level
AENL= Average Evening Noise Level
DNL= Daytime Noise Level
MNLR = Maximum Noise Level Recorded
PL= Permissible Limit

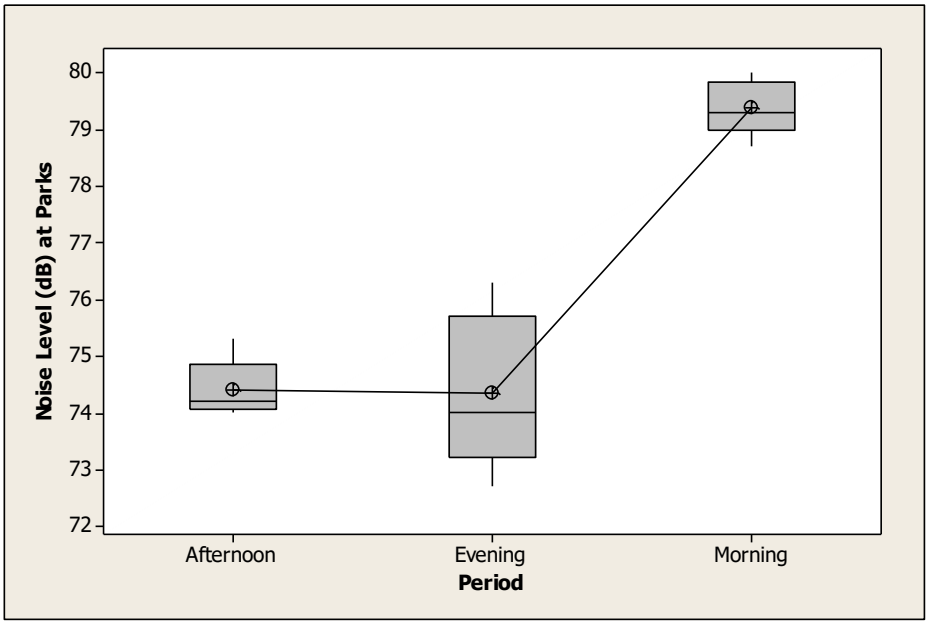

Figure 3: Box Plot of Periodic Noise Level at Motor Parks in the FCT

DISCUSSION

The present study has determined the noise level at seven designated noise sources within the Federal Capital Territory Abuja and its environs. The detemination of noise level using validated mobile/tablet application software has achieved good results as prevuously recommended in monitoring environmental noise (Maisonneuve *et al.,* 2010; Leao *et al.,* 2014; Ibekwe *et al.,* 2016). Noise level from five designated sources calls for serious concern as it is found above permissible limits. Among the implicated sources of noise that exceeded the WHO/NESREA limits, highways (81.5 dB) came top. Wuse area was was found to be very noisy as daytime noise level was 81.5 dB in highways thereby exceeding WHO/NESREA noise limits. The proximity of residential areas to busy roads could intensifies the impact of transportation-related noise pollution on individuals (Mobasseri and Soltani, 2014). Cars, trucks, motorcycles, and buses generate significant noise levels due to engine noise and tire friction,

The above findings could have serious implications on the wellbeing of those working and living in the FCT and it environ due to frequent exposure to noisy environment. Many studies have reported the ill effects of excessively high noise level on human health among which are hearing loss, sleep disturbances, increased stress levels and cardiovascular problems, such as hypertension and heart disease (Basner *et al.,* 2014; Ibekwe *et al.,* 2016). It was also reported that it could impair concentration, hinder productivity, affect cognitive performance in both adults and children and cause annoyance thereby reduce the overall quality of life (Gupta *et al.,* 2018). Sorensens *et al*. (2011) noted that a 10dB increase in chronic exposition of noise in humans increases the risk of cardiovascular accident (CVA) by 14% and systolic blood pressure appreciation by 0.26mmHg. This was confirmed by Erikson *et al*. (2012) who stated that a persistent noise level ≥50dB is associated with the risk of cardiovascular disease.

The FCT environment, as the seat of the Federal Government of Nigeria which accommodates all public parastatals, is expected to be serine and peaceful because it is where decision making and governmental activities that affect the entire nation takes place. A study by Ibekwe *et al.* (2016) revealed a progressive encroachment and unauthorized conversion of many residential areas in Abuja into business outlets have had consequent increase in human and vehicular traffic. The present study is in agreement with outcome of other previous assessment of noise level in commercial nerves of Yenagoa metropolis, South-South Nigeria (Arokoyu *et al.,* 2016); Ota South West Nigeria (Usikalu and Kolawole, 2018) and Makurdi North Central (Ugwuanyi *et al*., 2004). On the contrary, Oyedepo *et al.* (2019) carried out noise level measurement at 41 different locations in Ota metropolis, Nigeria where they obtained 96 dB at commercial areas. Anomohanran *et al*. (2008) also found that the peak noise level at road junction in Abraka, Nigeria to be 100 dB(A).

Motor parks came second as source of noise in the FCT as the daily noise level of 76.1 xceeded both WHO and NESREA limit. The five motoparks genetated much noise beyond the regulatory limits in the FCT. The daytime noise level was 76.1 dB where it was as high as 80.0 dB in the morning time. Noise is generated from public address system that calls help travelers locate the buses they are travelling with. Noise is also generated from high volume of vehicular movement in and out of the park, and those generated among the travelers and those selling their goods within the parks. Daytime noise level of was 77.1 dB at El-Rufai Park Nyanya was the highest recorded. The worst hit are the traders who are exposed to this noise level for more than 8 hours in aday and those who help drivers/passengers load their goods. The daily crowd witnessed in the park could be a reflection of the human population in the city especially in the Nyanyan, Mararaba, Karu and Jikwoyi areas. This finding is in tandem with some reports that the Abuja

environs or outskirts are densely populated (Ibekwe *et al.,* 2016). This may therefore account for the high volume of traffics entering into the FCT on daily basis, thus imparting on the high noise level recorded.

The present study foulnd that noise generated in the morning and afternoon time was more than than the eveining noise. This could be attributed to the high volume of activities within the FCT in the morning and afternoon that exceeded regularory limits. However, night time noise level was found within normal values typical of a serine city. The identified sources of noise in this study are in tandem with other reports (Andringa and Lanser, 2013; Gadanya and Buhari, 2021). It is identified that automobiles, motorcycles, vehicular traffic, pressure horns, construction or industrial noise, machinery noise, electricity generating plants, and noise from religious worship are some the factors responsible for most of the noise experienced in Nigeria (Gadanya and Buhari, 2021). This outcome was also in tandem with the work of Anomohanram (2013) who recorded 83dB(A) in Abuja. To a large extent, the present investigation aligned with previous study by Ibekwe *et al.* (2016) who found 73 to 92dB(A) in Abuja municipals where day time noise levels at market and motor park areas of the Abuja municipality were generally high and mostly unsatisfactory. The authors found that the Jabi Park/Market was the nosiest part of the municipality mainly due to the very high human and vehicular activities within this confine. The noise level around the business areas and motor-parks in Abuja municipality has reached an unsatisfactory threshold and needs urgent attention. In this work, Jabi motopark was the second noisiest park after El-Rufai Park Nyanya. The rapid migration of internally displaced citizens as a result of insurgency and terrorism in the North-East, and daily migration of people into the city for business, contracts and greener pasture is believed to have increased human population in Abuja and its environs (Ibekwe *et al.,* 2016).

CONCLUSION

The outcome of noise levels from the two designated sources calls for serious concern as they were found above regulatory permissible limits. These include the highways (81.5 dB) and motor parks (76.1 dB). Noise was higher in the morning and afternoon than in the eveining. All nighttime readings were satisfactory. Noise levels that exceeded the regulatory permissible limits as astated above could have serious implications on the well-being of those working and living in the FCT and it environ due to frequent exposure to noisy environment. The noise data in this study are useful as reference and guideline for future regulations on noise limit to be implemented for FCT and other urban cities in Nigeria.

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Screening of SSR Molecular Markers for Polymorphism in Aphid Resistant and Susceptible Cowpea Varieties

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Abstract:
The aim of this study was to screen SSR markers for polymorphism in aphid resistant and susceptible varieties. Twenty-Two (22) Simple Sequence Repeat (SSR) markers were screened on aphid resistant (TVNu-1158 and TVu-2876) and susceptible (Aloka Local and Keffi local). varieties. These molecular markers were used to identify polymorphism between the resistant and susceptible cowpea varieties using the PCR technique. Polymorphic indices of primers were generated on the PICcalc DEMoMa application v2012. Primers showed different banding and clustering patterns. Results showed that 17/22 (77.3%) of the primers produced a total of 79 visible bands. Six (6) primers (27.3%) had PIC >0.50 and were considered polymorphic. They were: EX-78, EX-79, C42-B, RB-45, JL 31/32 and CP-253/254. The first five primers had PIC of 0.99 each as the highest value recorded. The maximum Marker Index (MI) recorded was 2.96 while the Effective Multiplex Ratio (EMR) was highest in CP-253/254. Polymorphism was higher in the aphid susceptible varieties than the resistant varieties in the following order: Keffi Local (27%), Aloka Local (26%), TVu-2879 (24%) and TVNu-1158 (23%). The highly polymorphic primers as stated in this report are effective candidates for developing varieties for aphid resistance in cowpea breeding.

Keywords: Aphid resistance, Cowpea, SSR marker, DNA polymorphism, Breeding

INTRODUCTION

Cowpea [*Vigna unguiculata* [L.] Walp] is one of the most important food legumes of vital importance to the livelihoods of millions of people in West and Central Africa (Boukar *et al.*, 2018). Cowpea belongs to the Fabaceae family and is grown agriculturally for food, animal feed and generation of cash (Mhango *et al.*, 2013). It is an annual herbaceous legume largely grown in the West and Central African countries. Nigeria produces about 3.5 million tons of cowpea from a cultivated land area of 3.5 million ha, making it the world largest producer (FAOSTAT, 2017). Nigeria is the 2nd highest consumer of cowpea in the whole world. The crop is one of the most important food legumes of vital importance to the livelihoods of millions of people because it is a multipurpose crop that is used as food, fodder and as a source of income. The seed provides a cheap source of protein to the subsistence farmers and also provides a range of essential micronutrients and vitamins (Boukar *et al.*, 2018). However, cowpea is affected by pests and diseases at different stages of development leading to a drastic reduction in yield (Adegbite and Amusa, 2010; Boukar *et al.*, 2018) and deterioration of seeds during storage (Keneni *et al.*, 2011).

Cowpea aphid (*Aphis craccivora* Koch), is a specie of insect pests that affect cowpea production, in that it causes significant yield losses (Ikwelle and Okello, 2021).

Conventional breeding seems to offer a possible solution to several biotic stresses of cowpea. However, it may require a decade or more to develop and release a new cowpea cultivar because it involves screening and identifying appropriate resistant germplasm sources and then introgressing the resistance trait (Omoigui *et al.*, 2019). Molecular breeding tools, including marker-assisted selection, have the potential to accelerate and improve the effectiveness of breeding for disease resistance in many crops. DNA polymorphism refers to the presence of genetic variation within a population or species. It is a condition where there are multiple forms or variants of a particular DNA sequence or gene at a specific location in the genome (Jiang *et al.*, 2021). In spite, of greater efforts in discovering the aphid resistance genotypes, resistance to aphids (*A. craccivora*.) of most of the identified cowpea cultivars has recently broken down, due to the occurrence of resistance-breaking down biotypes, in various plant-aphid systems. Lack of polymorphic DNA markers needed in the identification of new sources of resistance to *A. craccivora* has been a major challenge in the breeding system. The aim of this study was to screen SSR markers for polymorphism in aphid resistant and susceptible varieties

MATERIALS AND METHODS

Genetic Resources

Seeds of aphid resistant (TVNu-1158 and TVu-2876) and susceptible (Aloka Local and Keffi local) varieties were obtained from the Molecular Biology Laboratory, Department of Plant Breeding and Seed Science, Joseph Sarwuan Tarka University.

Screening of Molecular Markers

Twenty-Two (22) Simple Sequence Repeat (SSR) markers designed for resistance to biotic stresses were screened on aphid resistant and susceptible varieties.

Planting of Cowpea Seeds in the Screen House and Collection of Leaf Samples

The four varieties of cowpea were planted in pots containing top soil. Three seed from each variety was planted in each pot containing top soil and was tinned to two seed at ten (10) days after planting to maintain two plants per pot. Leaf samples from young cowpea plants were collected for each variety at fourteen days after planting. The leaf samples were collected and stored in polythene zip-lock bags containing silica gel to dry for three days.

DNA Extraction (CTAB Method)

The CTAB (Cetyltrimethylammonium bromide) method of DNA extraction as described by Omoigui *et al.* (2012) was modified for cowpea leaf to obtain quality DNA for PCR reaction. The resulting pellets were washed with 600uL of 70% ethanol and suspended in 80uL of RNase water.

Polymerase Chain Reaction (PCR)

Polymerase Chain Reaction (PCR) was performed using 15µl total reaction volume. The components of the reaction included the following mixture: PCR premix beads (containing PCR Buffer, $MgCl_2$, DNTP's, and Taq Polymerase), distilled water, 1µl of each primer and 1µl of DNA (50ng). Simple Sequence Repeats (SSR) based PCR protocol (Omoigui *et al.*, 2012) was used in carrying out PCR amplification where 25 µl of molecular biology grade water was added into 0.2 ml eppendorf tubes containing the PCR beads. The mixture was then divided into two for two PCR reaction, 1 µl primer (marker) and 1 µl DNA sample to serve as template was added into each 0.2

ml eppendorf tube. A total of 35 cycles were programmed on the thermocycler, each cycle consisting of denaturation stage (94°C for 4.0 minutes), annealing stage (55°C for 1 minute), extension stage (72°C for 5 minutes) and final hold at 6°C.

Agarose Gel Electrophoresis and DNA Visualization

The Procedure used by (Omoigui *et al*., 2018) was adopted. Exactly 3.5% agarose powder was measured on the weigh balance and poured into a beaker containing 350ML 1xTAE buffer. The solution was allowed to cool and 30uL of Etbr was added and swirled gently then solution was poured on an already gel plate with comb. 1uL of DNA sample was added into the PCR tube then 1uL of 6x loading dye was also added. Samples were gently loaded into the wells using pipette and finally 5uL of ladder was loaded then electrophoresis tank was closed and gel start running 120v for 45minutes. DNA purity and quality was checked using Uv spectrometer light. The banding pattern of the samples resolved on agarose gel was viewed on a UV Bench top trans-illuminator and the gel image was captured using a camera according for band scoring and only distinct bands were scored.

Data Analysis

Binary matrix was generated from DNA banding profiles of gel images and analyzed on Minitab 17.0 software for clustering pattern. Polymorphic indices of primers were generated on the PICcalc DEMoMa application v2012 (Hansi, 2022). The information uploaded on the software included: number of alleles detected from each marker, number of examined genotypes, number of different bands in each primer, number of polymorphic bands in each primer, total number of bands in the gene pool and frequencies of alleles. The output generated the following indices of polymorphism: H- value (Heterozygosity of primers), PIC (Polymorphic Information Content), EMR (Effective Multiplex Ratio), M1 (Marker Index) and RP (Resolution Power).

RESULTS AND DISCUSSION

Banding Patterns of SSR Primers in Aphid Resistant and Susceptible Cowpea Varieties

Plates 1 and 2 show the agarose gel images of 22 screened Simple Sequence Repeats (SSR) Marker employed in the DNA amplification for polymorphism between Aphid resistant cowpea varieties (TVu-2876 and TVNu-1158) and susceptible cowpea varieties (Aloka Local and Keffi local). The primers showed varying degrees of genetic polymorphism depending on the DNA of the cowpea varieties amplified and the SSR primer used. Similar results on genetic polymorphism were reported in different cowpea varieties selected for Striga resistance using SCAR markers. (Omoigui *et al.,* 2012). All primers used in the present study produced visible bands except in Ex-15, MS118 and 1989-1F. DNAs of aphid resistant varieties (TVu-2876 and TVNu-1158) were well resolved in primers Ex77, Ex78, RB45, 59f/r and 48f/r primers. In susceptible varieties (Aloka Local and/or Keffi local), sharp bands were observed in RB45, Ex24, Y24, 570-1F and 570-2F primers. The following primers produced sharp bands in at least one resistant and susceptible varieties: C42B, Ex20a, Ex39, CP253/254, CF2-5, MS143, JL31/32. The following primers were noted for producing sharp bands in the DNA of four varieties of cowpea amplified: C42B, CP253/254 and JL31/32. Resistance to aphid could be explained from the genetic point of view and it shows that the presence of genes controlling aphid resistance as previously reported by Braimah *et al.* (2022).

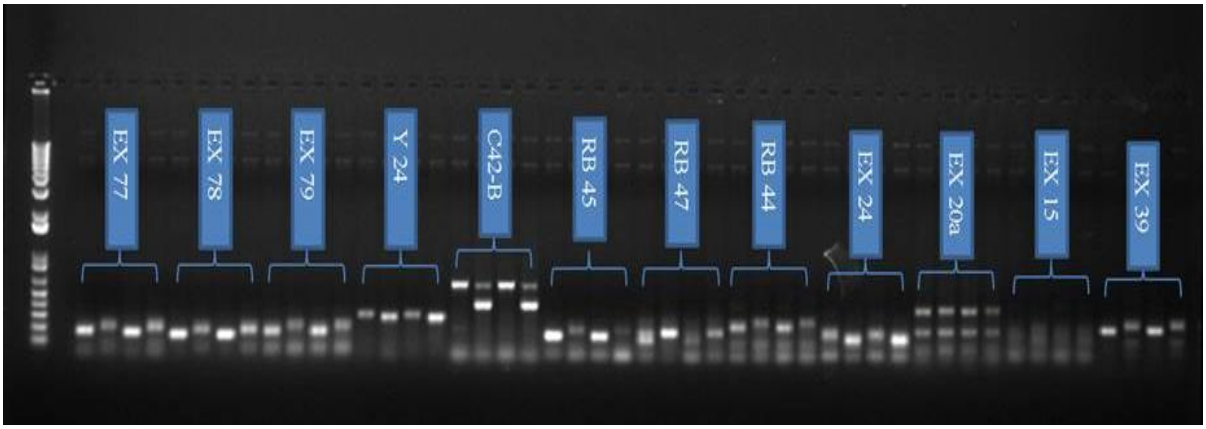

Plate 1: Agarose gel image showing screening of Twelve SSR markers (SET 1) for polymorphism between Aphid resistant cowpea varieties (TVu-2876 and TVNu-1158) and susceptible cowpea varieties (Aloka Local and Keffi local). Each group of four represents screening with a single marker as labelled. Lane 1 and 3 in each group is DNA from resistant parents TVu-2876 and TVNu-1158 respectively, while Lane 2 and 4 is DNA from susceptible parents Aloka Local and Keffi local respectively.

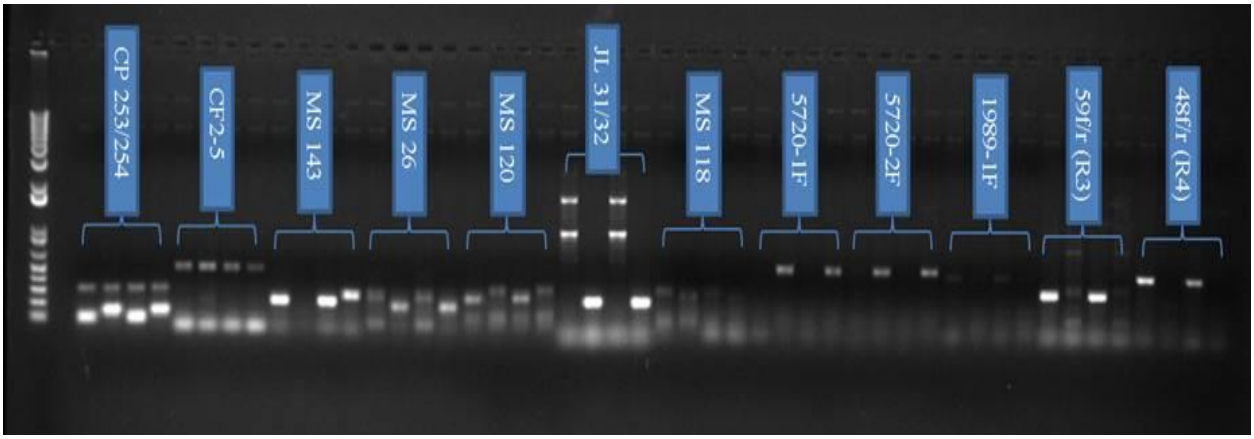

Plate 2: Agarose gel image showing screening of Twelve SSR markers (SET 2) for polymorphism between Aphid resistant cowpea varieties (TVu-2876 and TVNu-1158) and susceptible cowpea varieties (Aloka Local and Keffi local). Each group of four represents screening with a single marker as labelled. Lane 1 and 3 in each group is DNA from resistant parents TVu-2876 and TVNu-1158 respectively, while Lane 2 and 4 is DNA from susceptible parents Aloka Local and Keffi local respectively.

Table 1 presents the banding pattern of 22 SSR primers employed to identify polymorphism between aphid resistant and susceptible varieties of cowpea. Presence of bands were indicated by 1 or 2 to represent single or double bands respectively while absence of band was indicated as zero (0). Double bands were recorded in the four varieties as amplified by primers: CP253/254, EX77, X20a and CF2-5. Double bands were characteristic of only resistant varieties in primer JL 31/32. Double bands were characteristic of only susceptible varieties in primers C42B, RB45, EX-78 and EX-79. Band analysis in TVu-2876 variety (resistant type) showed 14 bands representing 63.6% of the total primers employed in the DNA amplification. There were 5 double bands (22.7%) and 9 single bands (40.9%). In Aloka Local (susceptible variety), there were 13 (59.1%) bands grouped into 8 double bands (36.4%) and 5 single bands (22.7%). In TVNu-1158 variety (resistant type), there were 13 (59.1%) bands grouped into 5 double bands (22.7%) and 8 single bands (36.4%). In Keffi Local (susceptible variety), there were 13 (59.1%) bands grouped into 8 double

bands (36.4%) and 5 single bands (22.7%). The above findings are indications of the co-dominant nature of SSR markers as revealing heterozygosity of alleles at specific loci. Researchers have demonstrated the presence of multiple repeats of sequences along the DNA known to detect polymorphism and monitor inheritance of resistance to specific diseases in plants (Duangsong *et al.*, 2018).

Table 1: Banding Pattern of SSR Primers to Identify Polymorphism Between Aphid Resistant and Susceptible Varieties of Cowpea

Primer	Sequence (F/R Primer)	TVu-2876	Aloka Local	TVNu-1158	Keffi Local
CP-253/254	GAAAGGGAAGGATTATGGGATA GGCAAATAGCGGGGTAGAGT	2	2	2	2
Y-24	GGTTTCCTAGTTGGGAAGGAA ATTATGCCATGGAGGGTTCA	0	1	0	1
EX-39	CAAGAGTCATTCGGCTCCTT GCTGCACCGTTTTCCGAAAT	1	0	1	0
EX-77	GATCCAACATTTCCTGTGTCTC GGAGCACCCGACAAGCCCCT	2	2	2	2
EX-78	ACTTCGCACACAGATCCAAC AATTGCCGGCTTTCCCATTG	1	2	1	2
EX-79	TTCAGACAGCATAGCTCCCA GGCCGTATCAAGGATGAACA	1	2	1	2
MS-120	TTTCTAGGCAGTGAAGATAATCA AAACAAAATACCAACTACCA	0	0	0	0
MS-143	ATGTTTCAGATCGGTTTAGA GAGCTGAAAAAATCGGTGTC	1	0	1	1
C42-B	GTAGGGAGTTGGCCACGATA CAACCGATGTAAAAAGTGGACA	1	2	1	2
RB-45	GAAGGCCCTTTAGGATCACC CATCGTTCAGCTGATGTTCG	1	2	1	2
RB-47	CAAAGGGTCATCAGGATTGG TTTAAGCAGCCAAGCAGTTGT	1	1	0	0
RB-44	CTACGCTGGTTATTCTAGGGGA GATAGAAGAAGAATGAGTAAGTAA	0	0	0	0
X-24	CGCTCCTCGCTGGCAAAAG CCTTCCCTACAGTGATATTTCCC	0	1	0	1
X20a	GCGCTGGATGGTCAGAGACA CAAGAGAAAAATGGTATAGA	2	2	2	2
X15	GGACTTGTTATAAACTATAG CCCGTAGAAGAGTACAAGAA	0	0	0	0
CF2-5	GTTTGTGCATAGATATCCCC CCCCCTCATCCTATAAACTCC	2	2	2	2
JL 31/32	GATGAGTGTGTGAACAAAGGAG CCCACATTCCATCATCCC	2	1	2	1
MS118	GACTTACTCCACTTAAACAAC GTTCCTGGTCCATCCTAATTTTCCG	0	0	0	0
5720-1F	TGCGGTTGAGATTTTGACGT CGTGAAGTTGAATGTGAAT	0	1	0	1
1989-1F	GTGGGCAGTGTCACCTTTTT GTGGAGCAACTGATTGCAGA	0	0	0	0

59f	GCAGAATCCTTGTGAACCTG TTTCGCAATATGCCCTTTTC	1	0	1	0
48f	GCAGAATCATTGTCAACCAG CGTCGCAATATGCCCATTTC	1	0	1	0

Determination of Relationships in Markers and Varieties

Primers were clustered on the basis of the DNA amplification results as shown in the dendrogram (figure 1). Genetic distance ranged from 1.11 to 2.12 with similarity coefficient of 76.7 to 55.7 respectively. There were two main clusters. The first cluster (cluster 1) comprised primers that amplified DNAs of the four varieties of cowpea (2 resistant and 2 susceptible). Four primers which produced double bands in all varieties (CP253/254, Ex77, X20a and CF2-5) formed a sub-cluster while JL31/32 primer which produced double bands in resistant varieties and single bands in susceptible varieties was a divergent lone entity among them. There were four primers that produced single bands in resistant and double bands in susceptible varieties (Ex78, Ex79, C42B and RB45) forming a sub-cluster. The second cluster (cluster 2) comprised primers that did not amplify DNAs of all the four varieties. Primers with single band DNA amplification only in the susceptible varieties but absent in the resistant types (Y24, X24 and 5720-1F) formed a sub-cluster. Primers with single band DNA amplification only in the resistant varieties but absent in the susceptible types (Ex39, 59f and 48f) formed a sub-cluster. MS143 was a divergent primer as it amplified DNA of only one resistant variety (TVu-2876) but two susceptible varieties. Primer RB47 was the most divergent in this group as it amplified DNA of the two resistant varieties but failed to amplified that of susceptible variety. Primers that failed to produce any amplification (MS120, RB44, X15, MS118 and 1989-1F) also formed a sub-cluster. Figure 2 shows the dendrogram of the four varieties of cowpea. They formed two groups on the basis of their responses to the 22 primers employed in the amplification of the DNA of aphid resistant and susceptible varieties. The resistant types (TVNu-1158 and TVu-2876) formed a group of higher similarity level (98.2) than the susceptible type (Aloka Local and Keffi Local) grouped together (79.4). Coefficients of similarity between the two groups were 0.04 and 0.41 respectively. It orders to apply these markers; it is important to understand the genetic inheritance pattern and heritability of aphid resistance in cowpea although it was reported to be controlled by two duplicate genes and makers were previously found linked to aphid resistance in cowpea. Also, QTLs controlling different aspects of aphid resistance in cowpea and other crops have been identified using SNP markers although monogenic aphid resistance has been established in the crop (Omoigui *et al.,* 2018). The selection of divergent SSR markers as presented in the dendrogram may be explored to further substantiate the nature of genes controlling aphid resistance,

Assessment of Polymorphic Indices

Table 2 presents indices of polymorphism of SSR primers among those that amplified DNA bands of cowpea varieties. It also gives information on the total number of bands and relative polymorphic bands (RPB) of the SSR primers. The 22 SSR primers produced 79 bands. Maximum of 8 bands were recorded in four primers (CP-253/254, Ex77, X20a and CFS-5) each with RPB of 10.1%. Heterozygosity of primers (H) ranged from 0.18 to 0.99. Results showed that 17/22 (77.3%) of the markers produced visible bands. Out of these, 6 primers (27.3%) had PIC >0.50 and were considered polymorphic. They were: EX-78, EX-79, C42-B, RB-45, JL 31/32 and CP-253/254. The first five primers had PIC of 0.99 each as the highest value recorded. The maximum Marker Index (MI) was 2.96. Effective Multiplex Ratio (EMR) of primers was highest in CP-253/254. Resolution Power (RP) was between 32.0 and 35.5. The markers screened in this work had high power of

resolution (>30) but 6 polymorphic out of 17 primers that produced bands. Primers are considered polymorphic when the 0.50 bench mark is surpassed (Ogunkanmi *et al.*, 2014; Olasupo *et al.*, 2018). The PICs of primers reported in many studies were lower than the 0.99 maximum value reported in this work. For instance, maximum PIC of 0.51 was reported by Olasupo *et al.* (2018) while 0.71 was reported by Ogunkanmi *et al.* (2014). The above finding is consistent with other reports where markers were screened and selected for their effectiveness in breeding work based on their polymorphic indices (Boukar *et al.*, 2016; Qin *et al.*, 2017; Omoigui *et al.*, 2019). Polymorphism was higher in the aphid susceptible varieties than the resistant varieties in the following order: Keffi Local (27%), Aloka Local (26%), TVu-2879 (24%) and TVNu-1158 (23%) as shown in figure 3. It suggests that the local landraces could be repository of genetic resources harboring diverse genes of interest. This view was earlier suggested in the work of Adejumo *et al.* (2021) who analysed the cytogenetic of some wild and cultivated species of cowpea. The outcome of this study is in conformity with some findings on the usefulness of SSR marker in varietal identity and selection as well genetic diversity of improved cowpea varieties (Dhakal *et al.*, 2019; Olasan *et al.*, 2023). Meanwhile Braimah *et al.* (2022) earlier elucidated the genetic diversity and relationships among cowpea genotypes for resistance to cowpea aphid using SSR markers. The outcome of their work agreed supports the present report. Marker-assisted selection (MAS) is embraced to allow timely development of new crop varieties. The principle is based on markers linked to quantitative trait loci (QTL) which are regions within a genome containing genes associated with a particular quantitative trait (Collard *et al.*, 2005). It helps to deal with complex and low-heritability traits. The complexity in the inheritance patterns of resistance in cowpea and the challenges associated with the measurements of the trait in the field or greenhouse make aphid studies a perfect target for MAS (Frejus *et al.*, 2020). Omoigui *et al* (2017) successfully developed and applied a marker-assisted selection strategy that employs a single backcross programme to introgress *Striga* resistance into farmer preferred varieties of cowpea for the Nigeria savannas. They introduced the *Striga* resistance gene from the donor parent IT97K-499-35 into an elite farmer preferred cowpea cultivar 'Borno Brown'. The selected 47 BC1F2 populations confirmed the recombinants with desirable progeny having *Striga* resistance gene(s). Therefore, the selected markers with high PIC and MI values reported in this study could be applied in the improvement of the aphid susceptible varieties using the resistant lines. This is because the development and deployment of cowpea varieties with resistance to pest infestation is the most cost effective and economically friendly approach to combat insect pests (Duangsong *et al.*, 2018).

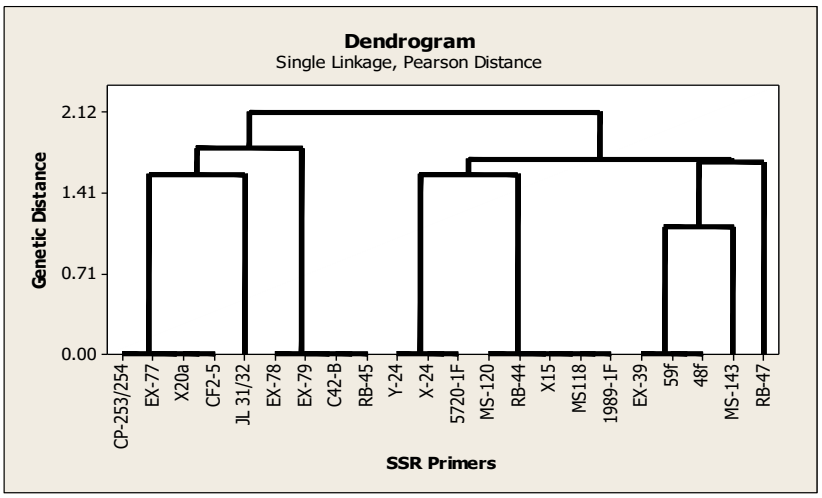

Figure 1: Dendrogram of SSR Primers

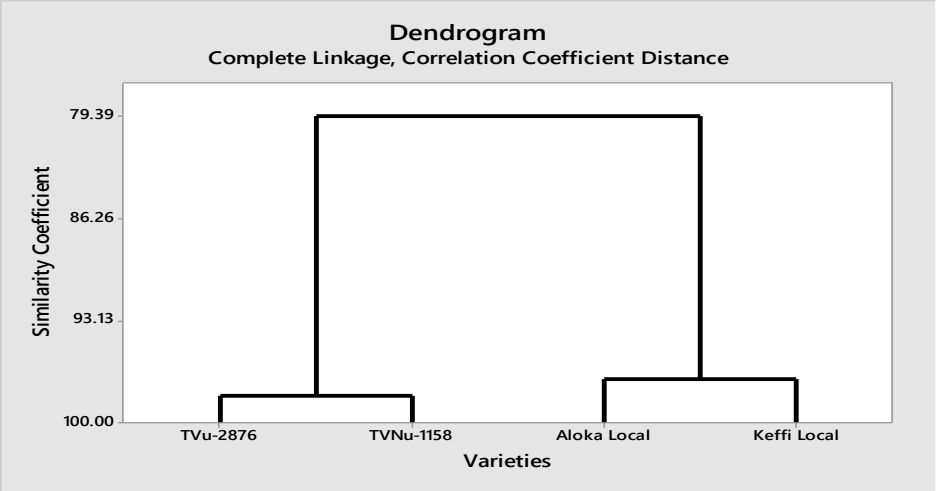

Figure 2: Dendrogram of Cowpea Varieties

Table 2: Polymorphic Indices of SSR Primers

Primer	Total number of bands	H value	PIC	EMR	MI	RP
CP-253/254	8	0.75	0.70	4.00	2.81	31.5
Y-24	2	0.18	0.16	0.50	0.08	35.5
EX-39	2	0.18	0.16	0.50	0.08	35.5
EX-77	8	0.54	0.47	1.33	0.62	32.0
EX-78	6	0.99	0.99	3.00	2.96	33.5
EX-79	6	0.99	0.99	3.00	2.96	33.5
MS-143	3	0.50	0.38	0.50	0.19	34.0
C42-B	6	0.99	0.99	3.00	2.96	33.5
RB-45	6	0.99	0.99	3.00	2.96	33.5
RB-47	2	0.18	0.16	0.50	0.08	35.5
X-24	2	0.18	0.16	0.5	0.08	35.5
X20a	8	0.54	0.47	1.33	0.62	32.0
CF2-5	8	0.34	0.31	1.33	0.42	33.5
JL 31/32	6	0.99	0.99	3.00	2.96	33.5
5720-1F	2	0.18	0.16	0.50	0.08	35.5
59f	2	0.18	0.16	0.50	0.08	35.5
48f	2	0.18	0.16	0.50	0.08	35.5
Total	79					

H= Heterozygosity of primers; PIC= Polymorphic Information Content of primers; EMR= Effective Multiplex Ratio of primers; M1= Marker Index; RP= Resolution Power

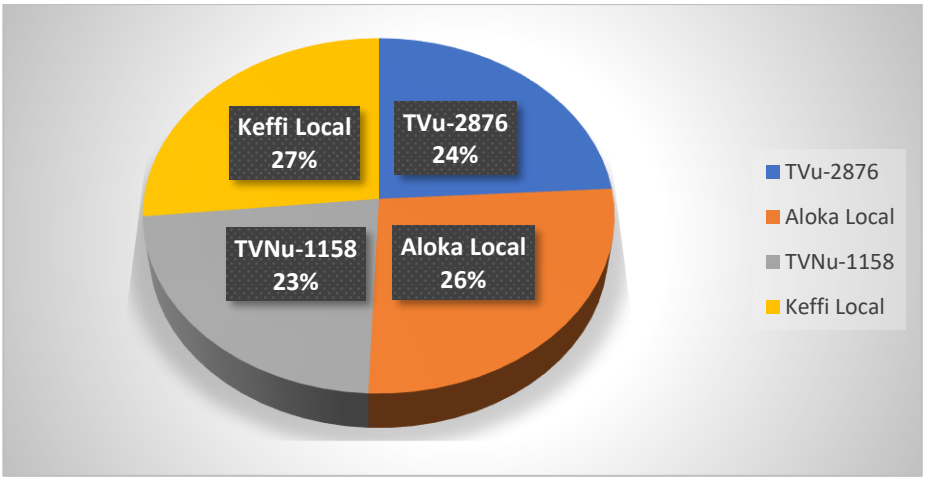

Figure 3: Percentage Polymorphism among Four Cowpea Varieties

CONCLUSION

The markers screened in this work had high power of resolution (>30). Results showed that 17/22 (77.3%) of the markers produced visible bands. Out of these, 6 primers (27.3%) had PIC >0.50 and were considered polymorphic. They were: EX-78, EX-79, C42-B, RB-45, JL 31/32 and CP-253/254. The first five primers had PIC of 0.99 each as the highest value recorded. The highly polymorphic primers as stated in this report are effective candidates for developing cowpea varieties for aphid resistance. There is need to screen more cowpea varieties and markers for resistance and polymorphism respectively to facilitate breeding programme.

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The Problem of Acute Nonspecific Inflammation of Lung Tissue in the 21st Century

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Our actions in response to current events, our decisions that we make to protect ourselves and withstand sudden disasters and trials, directly depend on the level of our knowledge and understanding of the phenomena occurring. This approach is a logical reflection of our orientation in the environment and serves as an explanation for our reaction and subsequent actions to a sudden change in the daily situation. Therefore, when in ancient times people did not know about the causes of the origin of such phenomena as, for example, thunder and lightning, they prostrated themselves with fear, explaining these phenomena to themselves with the help of their own imagination and the most incredible mystical assumptions.

Today, in the twenty-first century, science has reached an unprecedented depth of knowledge and allows us to solve practical problems that not so long ago seemed to be from the world of fiction. In modern conditions, when professional training is at the forefront of scientific research, and any information on a topic of interest is easily accessible, it is impossible to understand the logic of specialists in certain fields and topics in which a set of criteria for proposed assessments and conclusions focuses only on one of the characteristics of a common problem, more resembling a system of assumptions than a comprehensively substantiated analysis of phenomena.

Such a casuistry in modern medicine, where the approach to current events and solving current problems does not take into account a number of important factors and signs, losing the logic of its justification, is the problem of acute nonspecific inflammation in the lungs (ANSIL). If you do not go into a deep and comprehensive analysis of the transformations observed in this section, then the assessments and interpretations disseminated in the media space look quite convincing even for those who have a medical education but do not have special training in this section. Therefore, for example, the emergence of the SARS-CoV-2 pandemic is presented as a sudden misfortune, from which modern medicine did not have reliable and effective means of countering and providing assistance, and, therefore, this phenomenon should be considered as an unexpected surprise of nature. Such an idea of this event and the unenviable role of medicine during the peak of morbidity corresponds not only to widespread sentiments and assessments, but also to the actual results that accompanied the entire period of this disaster. However, before looking for the origins of this phenomenon in the so-called conspiracy theories and even in global warming, which is already being discussed as a possible cause, it is necessary to conduct the most objective and comprehensive assessment of the role of medicine itself in the series of observed events.

If we consider this event from this angle, then the reaction of specialists to the failure of their own therapeutic efforts to help the sharply increased number of patients with coronavirus infection will be understandable. It was during this period that an unprecedented series of publications appeared in professional medical journals, the authors of which share their feelings of powerlessness and even fear in the face of a sudden ordeal (1-4). However, the deeper reason for these depressive moods is that the long-term hope, laid down from the bench of the institute and

unchanged over the past decades, despite the change in basic conditions, to consider antibiotics as the main therapeutic agent for inflammatory processes suddenly turned out to be inappropriate when the etiology changed dramatically in relation to viruses. Medicine did not have ready-made adequate replacements and solutions for such a turn of events, which, first of all, had a psychoemotional effect on professionals who suddenly lost the usual stereotype of work.

The situation with the provision of medical care to a large number of patients with coronavirus inflammation of the lung tissue, observed during the pandemic, was characterized in wide usage, including in the professional sphere, as the rapid spread of a sudden highly virulent infection, against which medicine had no adequate counteraction. Therefore, the possibility of providing assistance to such patients began to be discussed at the level of supportive and auxiliary means of treatment. However, if we look at the immediate background of this event, it becomes quite obvious that such statements should be considered either as guile or as an inadequate analysis of the foundations of the observed phenomenon.

Firstly, experts on the problem of respiratory diseases have long expressed concern about the fact that the number of viral pneumonia is growing, which accounted for almost half of the cases of this nosology in the world a couple of decades ago (5-7). At the same time, coronavirus was already not only known to modern medicine as a possible pathogen, but also caused at least two major epidemics, SARS and MERS, with severe lung damage and high mortality, and a direct analogy of the first of these epidemics with the nascent pandemic gave the latter the code name SARS-CoV-2 (8). In this regard, it is at least not entirely tactful to talk about the suddenness of the event, since almost twenty years have passed, during which scientific and practical medicine did not attach due importance to the observed trend. Although, on the other hand, attention should be paid to the foresight of some microbiologists and pharmacists who were able to lay the foundations of future vaccines for the prevention of coronavirus infection in advance.

Secondly, the deformation of professional ideas about the essence of ANSIL, which developed under the didactic influence of the exaggerated role of antibiotics in the treatment of these diseases, has not disappeared anywhere, continuing to determine the strategy of the basics of medical care. Huge resources were spent and many years of efforts were made in attempts to achieve early and reliable diagnosis of pathogens of acute pneumonia (AP), before only in recent years experts began to recognize the futility of such studies and recommend the empirical use of antimicrobials (9,10). However, these recommendations apply only to bacterial forms of AP. Only blind faith in the phenomenal therapeutic ability of antibiotics can explain their almost total use in patients with COVID-19 pneumonia, despite the fact that concomitant microbial infection has been detected only in isolated cases (11-15).

Thirdly, speaking of blind faith in the phenomenal ability of antibiotics in the treatment of inflammatory processes, one should not forget that their activity extends only to certain types of microorganisms and does not directly affect the mechanisms of the inflammatory process. This feature of antibiotics has been known since their introduction and remains unshakeable to the present. Over the long period of use of this therapy, there have been enough examples of a decrease in the effectiveness of these drugs, the emergence of resistant strains of pathogens and the need to develop more advanced antimicrobial formulas. These reasons led to the most intensive production of new varieties of these drugs in the period up to the 70s of the last century, which is figuratively called the golden age of antibiotics (16).

Fourthly, at the beginning of the antibiotic era, the discoverer of penicillin, A. Fleming, warned about the danger of developing resistant strains of bacteria (17), and the authors of the industrial version of this drug provided evidence of the rapid appearance of self-defense in bacteria from the aggression of antibiotics (18). As the previous link shows, these processes in the microflora around us had an intensive development long before the events of recent years, but throughout the entire period of antibiotic use, all efforts were directed at maintaining the active action of these drugs, without attaching significant importance to the growing resistance of microorganisms and constant changes in the etiology of nonspecific forms of inflammation. In the latter connection, a very significant event was the announcement by the World Health Organization (WHO) about microbial resistance as a global catastrophe not in the 70s of the last century, when this phenomenon was already obvious, but much later, just during the development of the SARS-CoV-2 pandemic (19). The timeliness of such a statement, in my opinion, was a necessary measure, since this step allowed, at least, to explain the situation in which practical medicine found itself in providing care to patients with coronavirus pneumonia.

Fifth, at present, the main goal of ongoing research and clinical trials remains the pathogen of AP, despite the obvious facts that are repeated at all levels, but remain properly underestimated. On the one hand, the statistics of the pandemic have clearly shown that the spread of the coronavirus means its rapid coverage of population groups that have not previously been in contact with it. However, the high probability of such contact of the body with the coronavirus does not mean the same high probability of the disease, especially in severe form. The infection rate of the population during the pandemic was many times higher than the incidence rate. Many infected people had no signs of this and learned about the presence of coronavirus only on the basis of special tests. Only a fifth of those infected needed hospitalization, and only 5% of the total needed referral to intensive care units (20-22).

However, despite the rather moderate statistical indicators, the real atmosphere of uncertainty and even fear that was observed during the pandemic was explained by the lack of any guarantees to avoid the disease, knowing in advance about the lack of specific and effective treatment. The widespread dissemination of such information on social networks undoubtedly played a role in whipping up negative sentiments, but in this case, we are talking about the influence of special circumstances that influenced professional assessments of the situation, which were mentioned above. The sudden increase in the number of patients with viral inflammation of the lung tissue and their isolated concentration in specialized departments have created completely unprecedented conditions for the staff working there, extreme in terms of physical and moral stress. The author of these lines found himself in similar working conditions in the early period of his career, when the most severe patients with AP began to concentrate in one of the departments of the clinic in order to provide intensive care at the proper level. In this regard, it can be noted that such situations not only create an excessive burden on staff, but also, by concentrating information, allow us to see the problem from a different angle (23). Now, during the pandemic, in addition to the atypical concentration of patients of the same profile, most specialists have not been able to professionally assess and accept the sudden loss of hope for routine antibiotic use.

In connection with the latter, it is only necessary to add one very significant characteristic, which many specialists, focusing on a new contingent of patients, are unlikely to check and, moreover, explain. Nevertheless, if we look at the mortality rates in intensive care units among patients with so-called community-acquired pneumonia on the eve of the pandemic compared with this

indicator for COVID-19 pneumonia during treatment in these departments, we do not see large differences (24-32). At the same time, according to modern standards and concepts, in the first case, patients received etiotropic therapy, while patients with coronavirus were deprived of it. These statistics show us that etiotropic drugs, which today continue to be considered as an expected means of saving lives, do not have a decisive impact on the results of treatment.

On the other hand, attempts at differential diagnosis of AP by the type of pathogen have been going on for many years and have not stopped until now, despite the completely unambiguous results of such studies. Earlier attempts were made to find fundamental differences in lung tissue inflammation depending on the type of bacterial pathogens, but over time such efforts began to be recognized as futile (9,10). During the pandemic, when, among the many modern variants of AP, another form of COVID-19 pneumonia appeared, which in clinical observations repeated the manifestations of previously known bacterial inflammation, new efforts were made to separate bacterial and viral forms of inflammation, which was dictated by hypnotically acquired attitudes of hope for targeted etiotropic treatment. The new efforts also did not bring positive results (13,33,34). However, despite the negative result of such studies, they, in my opinion, are a convincing factor reminding us of the need to remember that we are talking about a non-specific inflammatory process in which not the nature of the alleged pathogen, but organ dysfunction has always played a decisive role in its clinical manifestation. In this case, we return to the fifth classic sign of inflammation - loss of function, which was described at the beginning of our era by Galen and has passed convincing clinical trials and confirmation based on centuries of experience.

Even some of the inconsistencies listed above between modern professional ideas about the essence of AP and the real features of the development of this disease allow us to note deep misconceptions in the interpretation of the essence of this problem. The significant changes observed in the etiology of AP over the past decades could not have started spontaneously, but "strangely" coincided with the period of antibiotic use and were accompanied by other side effects of this therapy. At the same time, the stability of the learned guiding dogmas that define the modern principles of treatment for this category of patients cannot but amaze. What other evidence is required for such a conclusion, when during the SARS-CoV-2 pandemic, the use of antibiotics against coronavirus instantly lost its meaning, but continued to be widely and arbitrarily used, many times exceedingly even the permissible indications for their use in viral pneumonia (11-15)? The grotesque nature of such assistance to the sharply increased number of patients with viral lung tissue damage was emphasized by the long overdue recognition of the development of resistant microflora as a worldwide catastrophe with the negative role of antibiotics in this phenomenon during the pandemic (19).

However, a strategic mistake in the modern concept of AP remains the persistent concentration of attention on the etiology of the process, in which the pathogen is assigned the role of the main cause of the disease. Modern medicine, without attaching special importance to the constancy of the AP clinic against the background of frequent changes in the leading pathogens, continues to hope for early diagnosis of etiology and the search for effective etiotropic agents. At the same time, early functional disorders in patients with AP are still trivially explained by impaired gas exchange at the level of ventilation and alveolar diffusion, concentrating all available means of care and support on these causes. The active discussion that unfolded on the margins of professional periodicals during the pandemic caused confusion due to the narrow concentration of their attention only at certain stages of gas exchange. The struggle to increase the percentage of oxygenation using various techniques and devices extended only to methods of oxygen supply

and lung ventilation. The specifics of such a discussion simply force us to pay attention to the entire line of the respiratory cycle.

As you know, the main meaning of breathing is the delivery of oxygen and the removal of carbon dioxide at the level of tissues and cells of the body, which is simply unthinkable without such a stage of the respiratory cycle as blood circulation. At the same time, the irreplaceable role of pulmonary vessels in the general circulatory system and their functional antagonism with vessels of the large circle are known, the vital proportions between which are automatically maintained by the autonomous system of regulation of the small circle (35,36). In addition to this information, which belongs to the category of basic knowledge in teaching clinical disciplines, it is known that the cause of inflammatory tissue transformation is vascular damage. Knowing about these prerequisites, there should be no doubt that the chain of shifts in the general blood flow system in AP, which, unlike other localizations of inflammation, begins with damage to the pulmonary vessels, will have a different mechanism of development, right? But then where is the discussion of these issues when solving the AP problem? Today, in this section of medicine, everything is exactly the opposite. Despite the known differences between the two circulatory circles, the modern diagnosis of circulatory disorders and their correction in patients with AP are based on the same principles as in other localizations of inflammatory processes (37-39). Can such help bring success and satisfaction?

Along with negative assessments of medical care during the total invasion of coronavirus, some experts, on the contrary, note the great successes of health systems during the pandemic, arguing their opinion with positive results of antiviral vaccination (40). Without going into a discussion of the reasons for the need for frequent repetition of such injections and changes in the composition of vaccines, such a selective assessment of the prevention of coronavirus diseases does not even contain hints of an important and relevant comment on the results of treatment of hospitalized patients. After all, it was in this segment of work that medicine suffered the greatest fiasco, and medical care for this complex contingent, which was limited by the level of support and symptomatic means, requires the most detailed and critical analysis, does it not? Moreover, in fact, according to modern recommendations, we are talking about a viral variant of the so-called community-acquired pneumonia, which, when trying to make a differential diagnosis with bacterial forms of inflammation, turned out to be indistinguishable in etiology (33,34), which again reflected the lack of influence on the dependence of the specificity of the process on the type of pathogen.

Specialists who take responsibility for assessing the quality of medical care for coronavirus infection cannot but know that in the case of inflammation of the lung tissue, modern medicine continued to pin hopes on the widespread use of antibiotics and oxygen insufflation (11-15). Of course, when there are no options for critical assessment and suggestions for a way out of the current situation, it is easiest to silently ignore this information. However, the analytical value of the mentioned expert assessment acquires a completely different character and makes it possible to understand the stencil approach even to conclusions about non-standard situations if you read an editorial in the same journal that appeared quite recently, at the peak of recent events. According to the positions presented, the authors of the last interview (40) were among the co-authors of the statement published by the editorial board that the cause of the negative results of an unexpected disaster should be sought in the incompetent political leadership of the state (41). Such statements, when the causes of one's own mistakes are sought on the side and even the thought of possible professional misconceptions in this section of medicine, despite

counterarguments, is unacceptable, indicate that existing approaches to solving the problem of AP have reached their bottom.

It is also worth noting the messages expressing pride and confidence in the professionalism of medical workers during the pandemic, which is reflected in the descriptions of the voluntary increase in the volume and duration of work performed during this unexpected ordeal, without additional compensation claims (42). However, in this case we are talking about dedication and dedication to the chosen profession, when the author and her staff felt the need to increase the volume of their work due to the sharply increased workload. But, unfortunately, such an increase in the volume of medical work does not change its direction and principles, which does not affect the final results in any way. There is no doubt that such enthusiasm gripped many members of the medical profession during the pandemic, but it did not lead to radical changes in its outcome.

A selective brief analysis of individual segments of the ANSIL problem in this context is used to draw attention to long-standing misconceptions in this field of medicine. The deformation of views on the essence of the problem under discussion has been formed for many years under the influence of unjustifiably overestimated possibilities of antibiotics, and the current tendency to view the problem through the prism of the leading role of the pathogen continues to determine the current search for solutions. False ideas about the leading role of etiology in non-specific forms of lung tissue inflammation have been refuted in previous years by the results of additional objective studies and clinical trials (23). Today, these materials are confirmed by the constant addition of new facts and evidence, but the conceptual ideas existing in modern medicine about the essence of the problem demonstrate an example of amazing inertia and immunity to growing contradictions.

Dear colleagues, the solution to the problem under discussion primarily depends on how thoroughly and comprehensively we evaluate all the parameters of the phenomenon under study. The current situation in the section of medical care for patients with AP is a clear example of a specific narrowing and selectivity of views on the essence of the problem with the manifestation of indifference and ignoring even those cardinal manifestations of the disease that are already proven facts. In this regard, before directing efforts to investigate possible indirect causes of the problem, such as, for example, finding ways to intentionally spread coronavirus (43) or the role of global warming in the development of such phenomena (44), it is necessary to critically assess the completeness of our own professional approaches to solving this problem. Bringing the system of views on the nature of ANSIL in line with the fundamental foundations of medical science will reveal the true priorities of this problem and decisively change the modern principles of treatment of this category of patients.

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Berberine Improves Glucose Homeostasis Through Insulin, Nkx – 6.1 and Pdx – 1 Gene Expression in Pancreatic Tissue

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Abstract:
The Berberine (BBR), herbal agent, has been used in Chinese traditional medicine. The present experimental study analyzed effects of BBR on glucose homeostasis, Insulin, Nkx 6.1 and Pdx – 1 gene expression in pancreatic tissue in diabetic rats. A sample of 100 adult Wistar male rats was selected according to study criteria and divided into five groups by random technique after induction of Diabetes mellitus by alloxan and BBR was administered orally for six weeks. Blood sera were separated at 3000 rpm (15 minutes) for biochemical analysis. Pancreatic tissue pieces were collected in RNAse free Eppendorf tubes. Gene Primers were purchased from M/s Macrogen. PCR was performed on Thermo Scientific GeneJET RNA Purification Kit (K0731, K0732). Data was analyzed on SPSS version 21.0 (IBM, incorporation, USA) at 95% CI (P≤ 0.05). Blood glucose, A1C, Serum Insulin, C-peptide, Insulin resistance (HOMA-IR) and β – cell function (HOMA- β) were improved significantly (P=0.0001). We observed significant overexpression of Insulin gene, Nkx 6.1 gene and Pdx 1 gene in pancreatic tissue after six weeks berberine therapy (P=0.0001). Quantification shows gene expression was dose dependent. Conclusion: Berberine induces insulin, Nkx – 6.1 and Pdx – 1 gene expression in pancreatic tissue.

Keywords: Berberine, Insulin gene, Nkx–6.1, Pdx–1, Pancreas

INTRODUCTION

Berberine (BBR) is an isoquinolone alkaloid derived from plants of *berberis* family. Various medicinal plants contain berberine alkaloid including *Phellodendron chinense* Schneid, Berberis lycium Royle, *Coptis chinensis* Franch, etc. It has been used in Chinese traditional medicine (CTM) since time immemorial extracted from the Chinese rhizomacoptidis. Manifold biological effects of BBR are known including the anti-diarrheal, anti-tumor, anti-hyperglycemic, antimicrobial.[1,2] It is considered a "secret prescription" recipe of CTM.[2] BBR has been used for treating obesity, hyperlipidemia and diabetes mellitus (DM).[1-3] Positive effects on glucose metabolism and insulin resistance (IR) have been reported possibly mediated through regulation of adenosine monophosphate- activated protein kinase (AMPK), insulin receptor expression and activation of protein tyrosine phosphatase 1 B.[1-5] Many studies[5,6] had found anti-diabetic activity of BBR similar to metformin. Later study[6] found anti-diabetic activity of BBR was mediated through expression of insulin receptor. Various studies[7,8] had reported its hypoglycemic efficacy through decrease in IR and improved β– cell physiology. As the DM is increasing in the modern societies including the developing countries[9], there is need to search for alternative therapy and herbs have

attracted much attention of scientists. Herbal agents have been experimented of their efficacy as anti – diabetic agent including berberine.[10,11] In this context of increasing prevalence of DM there is strong compulsion for analyzing new herbs for their anti –diabetic efficacy. The present study was planned to analyze the dose response effect of berberine therapy on Insulin gene, Nkx 6.1 and Pdx-1 genes in an alloxan induced Wistar male albino rat model.

METHODOLOGY

The present experimental study was conducted at the Faculty of Medicine & Allied Medical Sciences Isra University in collaboration Animal house of Sindh Agriculture University Tando Jam (SAUTA) from August 2019 to February 2023. 100 male Wistar albino rats were purchased from Animal Husbandry & Veterinary Sciences (SAUTA). Adult Wistar male rat of 150 – 200 grams, healthy, eating and moving well was the inclusion criteria. Lazy, sick male rats and female rats were excluded. Animals were lived-in stainless-steel cages with saw dust bedding. Cages were provided with plastic drinkers. Animals were housed according to guidelines as cited.[2] Animal environment was observed strictly according to criteria[2] and dark- light cycles of 12/12 hours were ensured. Feeding and tap water were available *ad libitum*. In phase – 1 the rats were selected according to the inclusion criteria, phase-2 the rats were induced DM with Alloxan (120 mg/kg) and in phase – 3 the diabetic animals were randomly divided into five groups. Group – I, negative control, Group II – positive control (diabetic rats), Group III – VI – diabetic rats + received BBR therapy of 50, 100 200 mg/kg bwt respectively. BBR was given daily for six weeks.[2] DM was defined as blood glucose ≥ 250 mg/dl at 72 hours.[2] BBR was given mixed in diet. After six-week BBR therapy, the rats were anesthetized by Ethylene- ether, blood samples were taken from retro-orbital venous plexus using capillary tube. Animals were sacrificed by cervical dislocation.[2] Pancreatic tissue pieces were in RNAse free Eppendorf tubes, stored at -80°C after frozen in liquid nitrogen for RNA isolation. Blood was centrifuged to get sera for biochemical analysis. Insulin resistance (HOMA-IR) and β – cell function (HOMA-β) was calculated and graded as cited.[12-14] Gene primers used for quantitative polymerase chain reaction (PCR) were purchased from Thermo scientific, Korea (Thermo Scientific GeneJET RNA Purification Kit (K0731, K0732) primers for the PCR were purchased from M/s Macrogen). Gene Primers included; insulin forward → 5- GGATTATTCATACCGTCCCA-3 (20 mer) and insulin reverse → 5- CACCTT TGTGGTCCTCACCT-3 (20 mer), Pdx – 1 forward → 5- GGGACCCCT CAAGTTTGTAA-3 (20 mer) and Pdx – 1 reverse → 5- GGCTTAACCTAAACG CCACA-3 (20 mer), Nkx – 6.1 forward → 5- GGG CTT GTT GTA ATC GTC GT -3 (20 mer) and Nkx – 6.1 reverse → 5- ACT TGG CAG GAC CAG AGA GA-3 (20 mer), 18s RNAr forward → 5- GTAACCCGTTGAACCCCATT-3 (20 mer) and 18s RNAr reverse →5- CCATGGAATCGGTAGTAGCG-3 (20 mer).[14] RNA was extracted according to procedure cited[15] and quantified. Negative control group I genes were taken as 1.0±0.0 for quantitative analysis[16] as ratio for comparison of gene expression in positive control and BBR treated experimental rats. Data was analyzed on SPSS version 21.0 (IBM, incorporation, USA). Analysis of variance and post – hoc Tuckey Cramer test analyzed the continuous variables. Significance of variable analysis results was taken at 95% CI (P≤ 0.05).

RESULTS

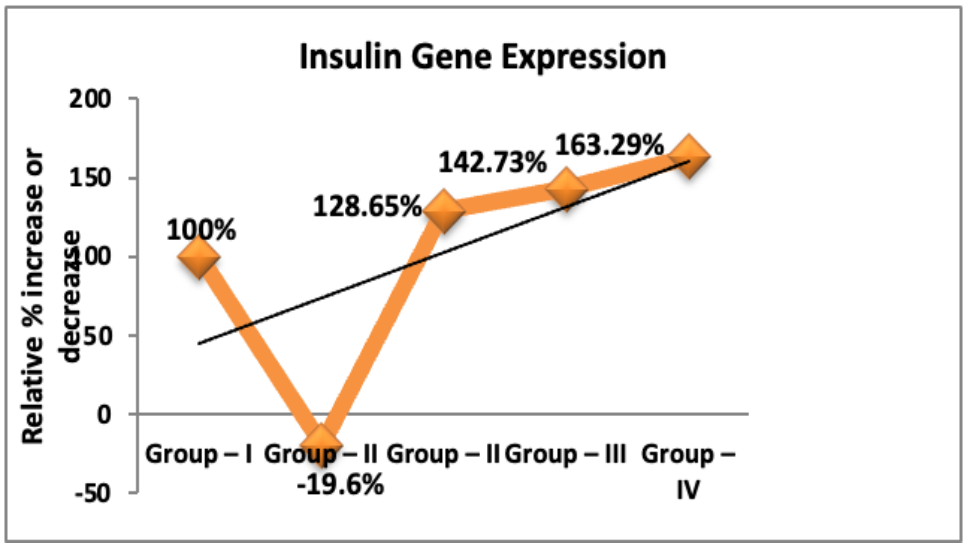
Blood glucose, A1C, C-peptide, Insulin resistance (HOMA-IR) and β – cell functions (HOMA-β) show significant improvement (P=0.0001) (table – 1). We observed significant overexpression of Insulin gene, Nkx 6.1 gene and Pdx 1 gene in pancreatic tissue after six weeks berberine therapy (P=0.0001) (table 2 – 4). Berberine induced gene expression was dose dependent (graphs 1 – 3).

Table – 1: Laboratory findigns in control and experimental rats

	Group I	Group II	Group III	Group IV	Group V	P
Fasting Glucose (mg/dl)	79.2±11.3	290.1±23.4	223.1±33.3	202.1±41.2	188.9±55.3	0.0001
Random Glucose (mg/dl)	123.1±8.7	399.0±34.2	323.1±9.9	320.8±18.8	207.6±29.4	0.0002
A1C (%)	5.1±0.6	8.66±0.72	8.14±0.69	7.08±0.78	6.48±0.50	0.0001
Serum Insulin (µU/L)	11.27±0.7	3.6±0.89	4.3±1.1	4.8±1.1	6.4±0.50	0.0003
Serum C-peptide (mg/dl)	1.74±0.6	0.40±0.27	1.01±0.15	1.13±0.1	1.27±0.20	0.0005
HOMA-IR	0.64±0.31	4.55±1.07	3.44±0.38	1.82±0.70	1.35±0.20	0.0001
HOMA-β	85.80±14.7	27.90±16.8	27.23±7.6	30.24±9.3	50.8±4.4	0.0001

Table – 2: Insulin Gene expression in Control and Experimental Rats

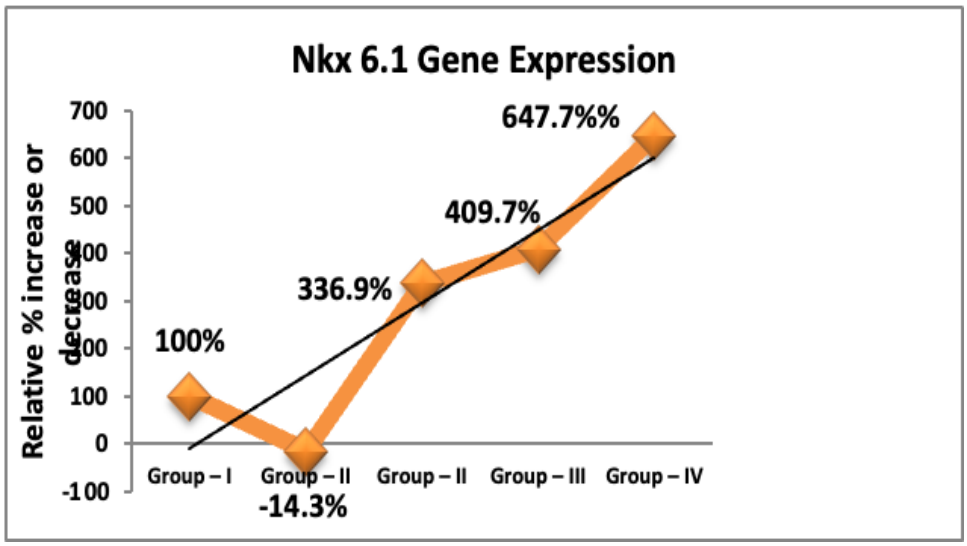
Groups	Mean	SD	SEM	95% CI of Mean		P
				LB	UB	
Group – I	1.000	0.000	0.000	1.000	1.000	0.0001
Group – II	0.196	0.235	0.052	0.087	0.306	
Group – III	12.865	1.072	0.240	12.364	13.367	
Group – IV	14.273	0.916	0.205	13.844	14.702	
Group – V	16.329	1.237	0.277	15.750	16.908	



Graph 1: Relative % increase or decrease in Insulin gene expression

Table - 3: Nkx 6.1 gene expression in Control and Experimental Rats

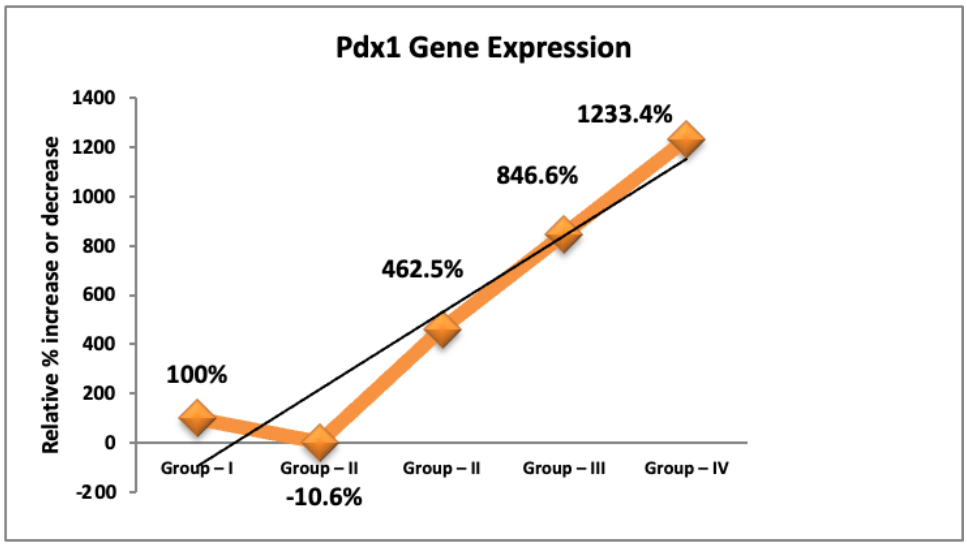
Groups	Mean	SD	SEM	95% CI of Mean		P
				LB	UB	
Group – I	1.000	0.000	0.000	1.000	1.000	0.0001
Group – II	0.143	0.096	0.021	0.098	0.188	
Group – III	3.369	0.636	0.142	3.071	3.666	
Group – IV	4.097	0.771	0.172	3.737	4.458	
Group – V	6.477	1.546	0.346	5.753	7.200	



Graph 2: Relative % increase or decrease in Nkx –6.1 gene expression

Table - 4: Pdx – 1 gene expression in Control and Experimental Rats

Groups	Mean	SD	SEM	95% CI of Mean		P
				LB	UB	
Group – I	1.000	0.000	0.000	1.000	1.000	0.0001
Group – II	0.106	0.092	0.021	0.063	0.149	
Group – III	4.625	0.688	0.154	4.303	4.947	
Group – IV	8.466	1.600	0.358	7.717	9.215	
Group – V	12.334	0.881	0.197	11.921	12.746	



Graph 3: Relative % increase or decrease in Pdx –1 gene expression

DISCUSSION

The present study is the first experimental study analyzing the dose response effect of Berberine therapy on glycemic control, Insulin Gene, Nkx 6.1 gene and Pdx – 1 gene expression. Experimental rats showed significant improvement of blood glucose, A1C, serum insulin, C-peptide, insulin resistance (HOMA-IR) and β – cell function (HOMA- β) after 6-week BBR therapy (P=0.0001). These findigns are consistent with previous studies.[1-5] However; novel finding of present study is the increased expression of insulin gene, Nkx – 6.1 gene and Pdx – 1 gene. In

present study, the Insulin gene, Nkx – 6.1 gene and Pdx – 1 gene expression was found high compared to negative control (group I) and positive control (group II) (table – 2 to 4). Insulin gene, Nkx 6.1 and Pdx 1 gene show statistically significant gene expression in BBR treated experimental groups (III – VI) compared to controls (P=0.0001). In present study, the insulin gene expression in positive control (group II) was 0.196± 0.235 (-19.6%) that was found over expressed in BBR treated groups. The BBR treated experimental groups III, IV and V revealed insulin gene expression ratio of 12.865±1.072 (128.6%), 14.273±0.916 (142.7%) and 16.329±1.237 (163.2%) respectively (P=0.0001) (table 2). The findigns are consistent with previous studies.[17,18] A previous study[17] demonstrated the effects of BBR therapy in mouse model and reported improved glycemic indices, insulin resistance and β-cells functioning. They further added the Insulin 2 gene promoter increases the AMP – PK activity that may be exploited for better diabetic therapy. In present study, the Insl Gene, Nkx 6.1 and Pdx1 expression were found elevated after BBR therapy hence the finding of gene over expression is in agreement with above study. A previous study[18] treated Zucker Diabetic Obese Rats with BBR for 12 weeks and demonstrated up – regulation of 91 gene and down – regulation of 63 genes in the livers of rats. Increased gene expression in liver is consistent finding with over – expression of Insl Gene, Nkx 6.1 and Pdx1 genes in pancreatic tissue of present study. Study by Wang et al[19] demonstrated reduced galectin-3 (Gal-3 mRNA) gene expression and suppression of obesity and concluded BBR may prove beneficial anti – obesity agent for obesity and diabetes mellitus. Similar to above findigns the over expression of Insl Gene, Nkx 6.1 and Pdx1 genes by BBR therapy may be exploited for improvement of glycemic control in diabetic subjects. In present study, the Nkx – 6.1 gene expressions in negative control were 1.00, and 0.143±0.096 (-14.3%) in positive control while berberine treated experimental groups III, IV and V show very high gene ratio of 3.369±0.636 (336.9%), 4.097±0.771 (409.7%) and 6.477±1.546 (647.7%) respectively (P=0.0001) (table 3). While Pdx1- m gene was expressed i.e., 4.625±0.688 (462.5%), 8.466±1.60 (864.6%) and 12.334±0.88 (1233.4%) in experimental groups III – VI (P=0.0001) (table 4) that also proved very high. Relative % increase or decrease of insulin gene, Nkx 6.1 gene and Pdx – 1 gene expression is shown in graphs I – III. Zhang et al[20] demonstrated up – regulation of MAPK (mitogen activated protein kinase) gene expression of MAPK8 and MAPK14 by berberine therapy, both genes augment insulin gene expression. This is similar to Nkx – 6.1 and Pdx – 1 of present study as both genes stimulate insulin gene expression. Our findigns of increased Insulin gene, Nkx – 6.1 gene and Pdx –1 gene expression is supported by above studies. Xia et al[21] concluded the BBR exerts hypoglycemic effect through gene inhibition of gluconeogenesis enzyme in the liver. They demonstrated the genes of 2 glucogenic enzymes; the Glucose-6-phosphatase (G6Pase) and mitochondrial enzyme Phospho-enol-pyruvate carboxykinase (PEPCK) were down regulated in the liver. Over expression β-cell gene expression of insulin and its transcriptor factors genes of Nkx – 6.1 and Pdx – 1 in pancreatic tissue is another novel pathway of glycemic control that needs further gene studies.

CONCLUSION

In conclusion, the present study observed berberine induces gene expression of insulin and its transcriptor factor genes Nkx-6.1 and Pdx-1 in pancreatic tissue in dose dependent fashion. Further studies, both animal and human are recommended to validate findings of present study and making berberine an alternative anti – diabetic therapy through gene stimulation mechanism.

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Using Nanotechnology in Food Packaging

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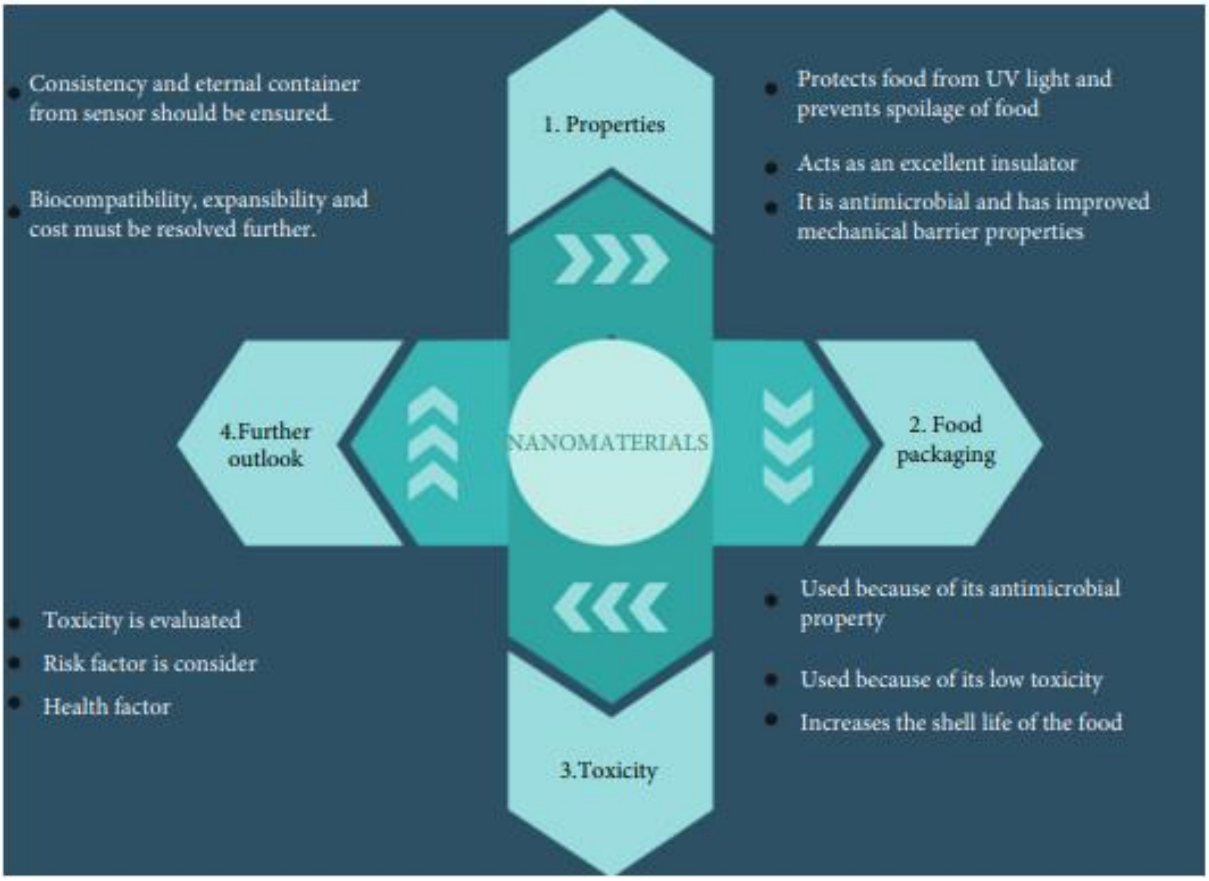
Abstract:
Nanotechnology is one of the emerging technologies that is used in various fields. This technique promises significant changes in the industry and health by improving the quality level. Today, one of the industries that plays a major role in the health of society is the packaging industry, and in a short period of time, it has made significant progress with the use of nanotechnology. In this article, the relationship between nanotechnology and packaging is explained with the help of data obtained from reliable scientific databases such as Science Direct, PubMed, and ResearchGate. The findings showed that nanotechnology can be used to improve health, gain wealth, improve the quality level of products, and according to all the mentioned cases, for a better life. However, food nanopackaging is still a relatively unknown field of nanoscience and food science that requires more extensive research.

Keywords: Nanotechnology, Food packaging, Sensors, Nanocomposites, Nanoparticles

INTRODUCTION

Sufficient and appropriate food supply has become one of the most basic concerns. In order to solve it, various efforts are made in different fields, such as increasing the amount of production, increasing the interest at the time of consumption, improving the methods of storage and storage, and developing methods of preserving it against harmful factors such as fungi and bacteria. It is done with it. In order to preserve food against fungi and bacteria and ultimately preserve it for a long time, the packaging is of particular importance (Khalid and Arif, 2022; Manzoor et al., 2023). Along with other new technologies that are used in the food classification industry, nanotechnology has found itself as one of the most common new technologies in the fields of different places in the food industry. This technology is an emerging technique that manipulates atoms and molecules in 1 to 100 nanometers and creates some unique and different chemical properties and behavioral characteristics so that different applications can be made from these materials. Creates in the field. Creates different (Primožič et al., 2021). Nano is a word originally from Greek and means dwarf and short and refers to a size equal to one billionth of a meter (eighty thousand times smaller than the diameter of a human hair) (Chadha et al., 2022). Advances in nanotechnology improve the quality of various products in issues such as safety, quality control, etc., or the creation of new materials. From the beginning, the role of nanotechnology in the industry has been to increase the capabilities of packaging materials, which include increasing the mechanical properties of resistance to impact and wear and preventing the entry and exit of gases inside the packaging materials. classified and mentioned... This technology increases the quality of products from color, taste, texture stability, aroma, freshness, and longevity (Primožič et al., 2021).

Key functions of packaging systems, i.e., container of the product, preservation and protection of the product quality, presentation and identification of the product as sales element, facilitation for transportation and distribution of the product, and information of the product to the consumers



OVERVIEW OF NANOMATERIALS IN FOOD PACKAGING

In current packaging, the use of glass, metal cans, and materials made from plastic compounds is common. The use of glass and metal cans due to reasons such as high weight, increased transportation costs, low resistance, less uniformity of dimensions compared to other containers, serious risks due to the presence of pieces or fragments of glass or metal, the possibility of corrosion by packaging materials (in relation to metals), opening the door and tampering with it, low safety and some other reasons have gradually been replaced by various types of plastic packaging made of polyethylene terephthalate, polyvinyl chloride, polyvinylidene chloride, acrylonitrile and polystyrene (Liu et al., 2022; Zhuo et al., 2023). But plastic containers themselves have many problems, including environmental pollution, the inability to reuse, and the migration of dangerous and carcinogenic pollutants such as catalyst residues, organic peroxides, metal salts, and monomers that are used in the formulation of plastic materials. have been used in food packaging (Agarwal et al., 2023). It seems that according to the issues raised, the use of nanotechnology in the packaging industry can solve these problems. The concept of nanotechnology was proposed in 1959 by Richard Feynman, a quantum theorist and Nobel Prize winner, at the annual meeting of the American Physical Society (Adassooriya et al., 2023). Nanotechnology or microparticles is a modern technology that is widely used for the production of new materials at the nanoscale due to its rapid growth (Malik et al., 2023). This technology is the science of very small materials with dimensions less than 100 nanometers that cannot be seen with the naked eye. In this technology, according to the size of the particles, physical and chemical properties change, which creates a wide range of applications. Nanotechnology has various applications in different fields, including food, medicine, biomedicine, medicine, biotechnology, textile, electronics, computer, cosmetics, paint, environment, lubrication, etc. (Malik et al., 2023). Their use in the packaging industry will be discussed further.

FOOD PACKING

Packaging means making or providing a container or protection that preserves the product's internal health during the period of time after harvesting, production, transportation, storage, and distribution until final consumption and is safe from possible physical or chemical hazards. In addition, the packaging should be cheap and light. The purpose of food packaging is to preserve the product, prevent bacterial spoilage, increase shelf life, and prevent damage during transportation and storage. Food packaging plays an important role in the safety and quality of food and can control the transfer of moisture and gases; As a result, it significantly reduces food waste. Common materials used in food packaging are metal, glass, and paper. During the last decade, the use of polymers and plastics has replaced other types of food packaging due to their low price, plasticity, and diversity in physical properties. has created in the food industry. But their main problem is the possibility of permeability of gases and other small molecules. On the other hand, these materials are produced from fossil fuels that are non-degradable and cause environmental pollution and serious problems for the environment. To increase the quality of food and design packaging materials to complement the needs of the food packaging industry, many efforts have been made to replace new biodegradable packaging made from renewable resources; It has been done. Packaging based on nanotechnology, which is used for this purpose, has created a great transformation in this industry. By choosing the right materials and technology in the packaging, the quality and freshness of the products can be maintained until the required time. Packaging using nanotechnology can be divided into three categories: smart packaging, active packaging, and improved packaging (Chadha et al., 2022; Chausali et al., 2022).

Smart Packaging:

Smart packaging includes labels that indicate the health and freshness of the product over time and also includes sensors. This system includes labels on goods or products that are identified by a radio device. Using this system, it is possible to remotely monitor the safety and quality of the closed product or the closed environment. This type of packaging informs the consumer of the product's condition in terms of food conditions and its environment to identify chemicals, pathogens, and toxins in food. This type of packaging with specialized nano-sensors and nano-devices gives environmental factors on food and also gives the efficiency of information transfer about color, quality, new products, etc. in time. From smart packaging food, absorbable food can be used in which it can be absorbed in the packaging and thus the growth of microbes and the taste and quality of the food. You can use it by using mineral-based chemicals. Carbon dioxide can form microbes in meat products such as red meat, meat, and cheese. Absorbent materials used in smart packaging include ethylene gas and antimicrobial materials. From nanotechnology in the manufacture of smart packaging to increase product life, it is possible to produce polymers with long-lasting characteristics against gas penetration and reinforcement, create functional coatings, etc. (Enescu et al., 2019).

An example of smart packaging with temperature-time indicators: temperature-time indicators to provide information about whether a threshold temperature has been exceeded over time and/or to estimate the minimum time a product will be above a threshold temperature (time) is placed, it is appropriate (Enescu et al., 2019).

Active Packaging:

In this method, active substances that are directly and indirectly in contact with food have the ability to change the composition of food or the atmosphere around it. This packaging changes the conditions of the package in a way that increases safety, increases the shelf life of food,

strengthens mechanical and thermal properties, maintains quality, and reduces costs. Antimicrobial packaging is a type of active packaging in which the shelf life of the product is increased with the help of antimicrobial agents that are used in the preparation of the packaging material to prevent the growth and reduction of microorganisms. In this packaging, the use of nanomaterials such as; silver copper oxide, silver oxide, titanium oxide, magnesium oxide, and carbon nanotubes that show antimicrobial properties in direct contact with food or its environment; is common in the meantime, the use of silver nanoparticles in food packaging as an antibacterial agent has grown significantly. Active packaging is developed mostly for antimicrobial applications. It has created many hopes for improving food quality safety and shelf life of food products (Chadha et al., 2022).

An example of active pads; Food pads are absorbents that completely cover the package on all four sides, no chemicals are released from them, and the fibers in the absorbent materials never come into contact with food, which increases the product's lifespan (Enescu et al., 2019)

Improved Packaging:

Despite the many advances in nutrition science, there are dangers with microorganisms such as mold, bacteria, and the existence of viruses that threaten human health. Since they directly consume antimicrobial substances in food, they can be useful for food consumption. Antimicrobial packaging is very important. One of these packaging is improved packaging, which includes polymer compounds along with the weight of nanoparticles and nanocomposites, which are used in products such as carbonated beverage bottles, films, and edible oils. One of the most important features of this classification is its prevention of gas entry, temperature regulation, food resistance, etc. The use of nanocomposite materials in the food industry is approved by the FDA (Akhila and Badwaik, 2022; Babu, 2022).

Application of Nanotechnology in Food Packaging

Scientists have identified the potential of using nanotechnology in almost all sectors of the food industry. Two of the most important areas are improved food processing, food quality, and food packaging. Among these two, nanotechnology is the most used in food packaging; Because they are not added directly to food, and the natural structure of the food is preserved in these conditions. The use of nanotechnology in food packaging will protect food against pathogenic

agents and harmful gases. Nanosensors are used in contamination detection and evaluation of packaged materials, as well as food protection against ultraviolet rays. This technology improves food packaging and its capabilities, and it can be used to detect bacteria in food packaging, which creates a better taste and quality of food, increases safety, and prevents penetration. gas and moisture, increasing shelf life and preventing food spoilage (Singh and Nanda, 2022).

as additives that have been used functionally in the food packaging industry; It is possible to use all kinds of nanomaterials; including silver nanoparticles, titanium nitride, zinc oxide, and nano-clay (Awuchi, and Dendegh, 2022).

Nanocomposites:

Reinforced polymers using nanoparticles are called nanocomposites, whose use has been developed in the food packaging industry. Compared to pure polymers, polymer nanocomposites have more strength, high resistance to ignition, better thermal properties, low melting point and gas transfer temperature, and suitable resistance to moisture conditions. In most cases, 5-weight clay nanoparticles have been used in the structure of nanocomposites. These nanocomposites are based on layered silicates of clay, for example, montmorillonite. The use of nano-clay in the design of nanocomposites leads to the creation of features such as high mechanical strength, and low weight, improving the properties of preventing the passage of liquids and gases, preventing the penetration of oxygen and moisture in food, and thus preventing food spoilage. be. A number of biopolymers including polyamide, nylon, polyolefin, polystyrene, epoxy polyurethane resins, and polyethylene terephthalate have been used in the design of nanocomposites based on nano clay. It is also possible to produce nanocomposites with thermoset and thermoplastic polymers, polyethylene, polypropylene, and poly methyl methacrylate. Research groups have started and studied the identification and preparation of biodegradable polymer nanocomposites such as starch and its derivatives, polylactic acid, poly hydroxybutyrate, etc. for a wide range of applications. The use of biocompatible nanocomposites in food packaging, in addition to preserving food, and increasing the useful life of food products, has solved biological problems and reduced the need to use plastics; It has improved mechanical, abrasion, and thermal properties, which is an important feature in packaging materials. Today, the use of biodegradable films of pure natural polymers in packaging is limited due to poor mechanical properties and poor performance in the entry and exit of gases. However, nanocomposites as a supplement in the formulation of packaging films have increased the hope of expanding the use of natural films. Polymer nanocomposites or bio-nano-composites are hybrid nanostructured materials with improved mechanical, thermal, and gas properties that cause less environmental pollution due to the reduction in the use of plastics in food packaging. These materials have more potential and stability in active food packaging industries to maintain antimicrobial activity and reduce the transfer of metal ion derivatives to packaged food (Perera et al., 2022).

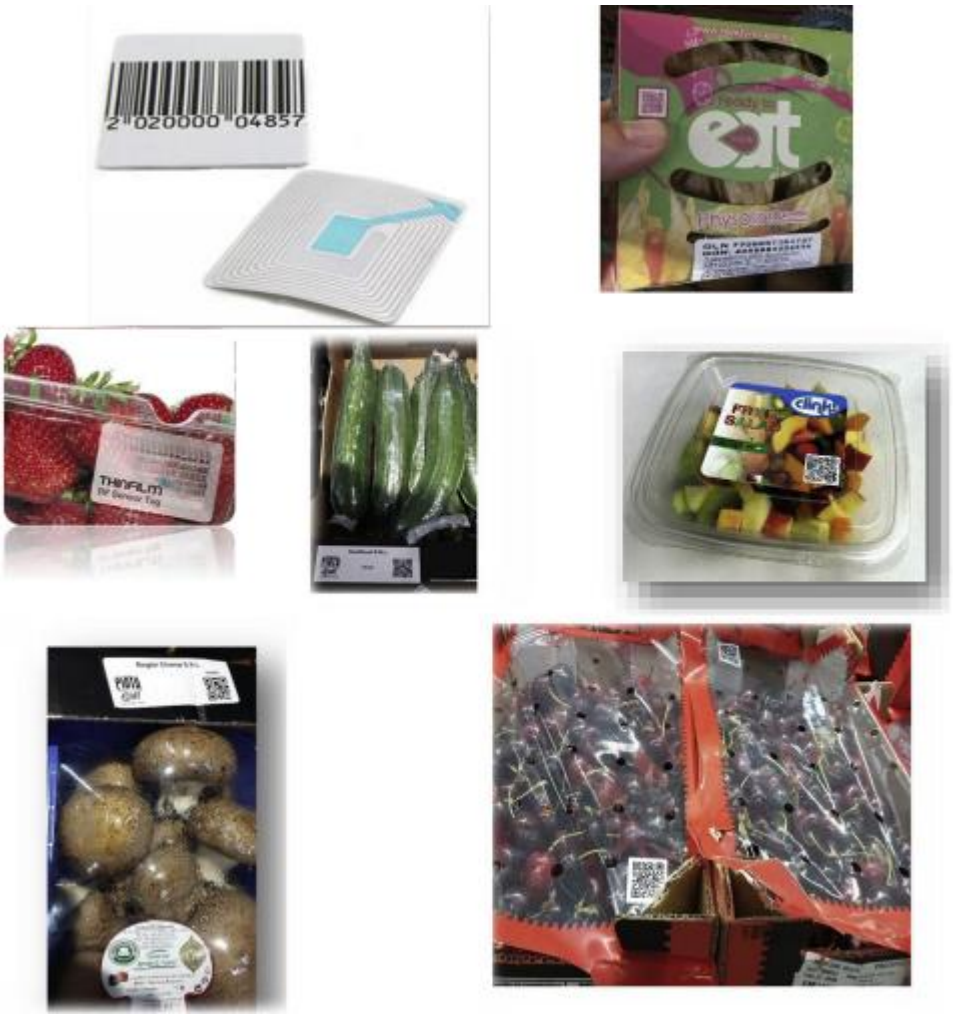
Coatings:

Nano coats were used several decades ago, and now they are generally used. Coatings are layers, a waxy coating that is of considerable interest and is used as coating products such as cheese and apples. The main role of nano-coatings is to protect food and also beautify packaging surfaces. Nano-coated foods have been used in a variety of foods such as meat, vegetables, fruits, cheese, candy, chocolate, fried potatoes, and bakery products. In general, nanocoatings are mostly used to prevent the passage of gases. Nanocoatings are antibacterial coatings without chemical germicides and are stable against chemicals, alkalis, and resistance. Nanocoatings are a fine layer that has an organic or inorganic origin, and their work is from penetration and migration, in the

packaging industry, these factors create quantitative and qualitative characteristics of food products. Nano-coatings made from materials such as titanium dioxide are used for photocatalytic disinfection. It acts as a chemical protective layer and plays the role of surface modifier (Mahmud et al., 2022).

Sensors:

In technology, the biosensor is an important option in the agriculture and food industry to ensure the quality and safety of food with cost-effective and fast methods, control products and processes, and detect packaged gases in order to ensure the integrity of the packaging. Different types of nanomaterials are used in the manufacture of biosensors, of which gold nanomaterials are one, these materials create other materials such as suitable, low, quick response, precision, and particles. The purpose of closing these materials in food packaging systems is to identify nanoparticles released in classified food in a short period of time, among their other uses, they can help to improve and detect pharmaceutical compounds, drugs, and substances. Sami pointed out. These materials can monitor the quality and freshness of food during storage and its sanitary conditions. Nano sensors react to environmental factors such as temperature, humidity, the effect of microbial factors and pathogens and provide useful information to suppliers and consumers in the conditions of storage of materials in terms of temperature, expiration date, etc.



An example of smart packaging with a sensor tag (advanced data carrier, capable of storing data up to 1 MB; this data includes traceability, inventory management, and improving quality and safety.) (Enescu et al., 2019)

Nanomaterials:
Many nanomaterials are used on an industrial scale in various food products, including nano clays, silver nanoparticles, as well as zinc oxide, silicon dioxide, and titanium dioxide... Silver, titanium dioxide, and zinc oxide are among the most important metal materials, and metal oxides that are used in packaging.

Dititanium Oxide Nanoparticles:
Titanium dioxide in a small size of about 1000 nm or less is used to improve food consumption and is antimicrobial in packaging materials and storage containers. Among the characteristics specified in the structuring, we can mention the increase in mechanical strength and help in the packaging process. This material protects plastics from UV rays. Rather, it causes the production of active oxygen (oxygen in the presence of ultraviolet rays and thus causes the analysis of pathogenic microorganisms.

Dicar titanium oxide nanoparticles are among the best semiconducting nanoparticles that have properties such as hydrophilicity, photocatalysis, ultraviolet light absorption, and antibacterial to prevent the growth of various microorganisms, gram-negative and gram-positive bacteria, and fungi as additives and antimicrobials. are. It is used for food and storage containers in the structure of polymer nanocomposites used in packaging. For packaging films coated by titanium dioxide to reduce Escherichia coliform on food surfaces.

Silver Nanoparticles:
One of the nanomaterials that are used in the food industry due to their antimicrobial properties is silver Nanocomposites, Silver is widely used as an antimicrobial agent in the food and beverage industry. This material prevents the growth of bacteria and Fungi in the packaging due to its permeable rather than non-consumable nature increases the shelf life of the product and does not change its appearance and properties. Due to their anti-bacterial and anti-odor properties, they are used in the packaging industry for sanitary materials. Because this substance has a catalytic property, it is used in the absorption and destruction of some materials in packaging, for example, ethylene, which is produced by the industries of fruits and vegetables, which makes them grow faster and reduces their shelf life. In the packaging of this type of food, silver nanoparticles are used in the packaging structure to absorb and analyze ethylene and thus increase their shelf life. These particles are mixed with nanomaterials to increase and improve the properties of packaging materials. In this process, silver nanoparticles release silver, which binds to cell walls, and ultimately leads to the inactivation of enzymes. Due to the lack of information about the materials of these nanoparticles on human health and their impact on the ecosystem, nanoparticles are not directly added to food and packaging. Another application of nanoparticles is to use them as nanocomposites. The physical and chemical properties of these materials are such that they exist and rotate on it. As a result, it causes oxidative stress. The packaging material has shown good antibacterial properties, for example, against samples such as *Escherichia*, *coliform*, and *Staphylococcus aureus*. One of the applications of silver nanoparticles is to use them in the form of silver zeolite. The antimicrobial activity of silver is due to the use of silver in the production of other types of chemicals that cause cell death.

Zinc Oxide Nanoparticles:

Nanoparticles of various metal oxides such as zinc oxide, magnesium oxide, and silver iron... Are used in packaging industries. Among these, one of the most widely used metal oxides is zinc oxide. This compound is white in color and has a vorticity structure and high mechanical stability. The range of applications of zinc oxide in nano fields is wide due to its piezoelectric, pyroelectric, and semiconductor properties. This compound has many applications in the medical field due to its biocompatibility, activity against ultraviolet rays, and good antibacterial properties (Ballesteros et al., 2022)

Nano Clays:

Nano Polymer becomes a two-phase system. These materials are composed of two organic and inorganic polymers that are formed from silicate layers. Due to their availability, low cost, and high acceptance, clay nanoparticles are used in polymers more than ineffective fillers such as clay, silicate, silica nanoparticles, etc., which results in lightness. The strength of resistance to heat and impermeability to gases can be mentioned. We can definitely say that clay nanoparticles are used in food packaging. The most important are composites. These nanocomposites are divided into two categories (1) internal nanocomposites and (2) multilayer structures of alternating polymers. They use bio-nano composites that are combined with non-mineral materials such as soil for food packaging. One of the main advantages of using these materials is their compatibility with the environment. Poly, amide, nylon, polyolefin, polystyrene, etc. can be mentioned among the biopolymers that are made on this basis. The combination of polymer and nano clay can be used in the packaging of various foods such as meat products, cheese, cereals, and juice. used (Schmitz et al., 2023).

Antimicrobial Properties:

The main application of nanotechnology in food packaging is its antimicrobial properties. The use of nanotechnology has provided many hopes for obtaining food with high safety capability, increasing storage time, and ultimately creating healthier food. The purpose of food packaging is to prevent microbial spoilage and the loss of nutrients and thus increase the storage time of food. One of the disadvantages of food is infectious diseases caused by contact with food, the primary source of which is milk. So; Eliminating bacteria in food packaging is one of the most important issues in the process of food production, processing, transportation, and storage. The use of nanomaterials has increased the useful life of food due to their antimicrobial properties (Suvarna et al., 2022).

CONCLUSION

Food packaging is one of the most important steps in food production, which is important for the shelf life of food. Meanwhile, the use of nanotechnology in food packaging has a special place and its value is increasing day by day. The important and fundamental principle of using this method is to maintain the safety of food, in this regard, important issues such as the type of packaging (e.g., Smart, active, and improved) and the number of antimicrobial properties of that type of nanoparticles suitable for achieving antimicrobial properties is considered. It is worth mentioning that in food packaging, these materials are used as disinfectants to increase resistance to light and heat and to prevent the attack of all kinds of microorganisms and pathogens. Finally, it is important to acknowledge that food packaging And paying attention to its quality along with paying attention to biocompatible materials is used as a determining priority and a determining role in increasing the quality of food, reducing the consumption of primary raw materials, reducing food consumption, maintaining individual and social health and vitality, and as a result,

resources For this purpose, for this purpose, for nanomaterials and their use in the food packaging industry, Melli Ayandag has found its place in this industry and with the increasing growth in the state of progress and development, it is needed and suggested. It is possible that different food industries, in addition to all their production activities, spend their capital and time on research to increase and improve the quality of the packaging of their products using different technologies, and in this way play their role in preserving national resources for future generations to do. Perform identification. Although nanotechnology has many collections, it still cannot be fully applied in relation to the non-influence of the materials used in it and their performance and human health and product safety. Because most of the review has been on it.

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Design and Implementation of A 10kVA 48VDC TO 220VAC Ferrite Transformer Based Intelligent Converter for Renewable Energy Utilization

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Abstract:
Power converters are systems that can convert electric power from one form to another through frequency manipulations using a complex network of frequency oscillators, signal conditioners, semiconductor switches and amplifiers. One common example of a power converter is a DC to AC converter with existing design methods based on converting a DC voltage signal to AC voltage using traditional iron core transformers. These systems are bulky and weighty with inherent high level of losses primarily due to the components used. This research seeks to modify existing 10kVA power converter whose output power signal is a modified sine wave with ferrite transformers and Insulated Gate Bipolar Transistors (IGBTs), to produce a pure output sine wave capable of powering household appliances. The approach is to equip the design with sensors that will make the system more intelligent than the existing converters. The objectives of this research include to produce a cheaper, smaller size, lighter weight, low loss, pure sine wave and voltage regulated power converter that makes the utilization of solar energy more efficient and provides an environmentally friendly alternative source of power supplies for homes and offices.

Keywords: Eddy current loses, Ferrite transformers, Pure sinewaves, Signal conditioners, Switch mode power supply.

INTRODUCTION

Background of Research

A DC to AC converter is a voltage signal inverting system that changes a DC voltage signal into an AC voltage signal. Low voltage DC signal from renewable energy sources such as batteries, photovoltaic cells and fuel cells can be converted to AC voltage signal for both domestic and industrial electricity needs. Converters can be achieved in different ways depending on the technique employed but the most reliable converter systems are those with sinusoidal output voltage waveforms which results from inverting or alternating a DC signal. The conventional AC voltage supply is a pure sine wave, and it is basically being simulated with the help of this conversion technology. Thus, the output of the conversion system is required to be as close as possible to a pure sine wave for effective utility. The basic converter designs involve creating a low frequency time-varying signal with two alternate outputs from a battery and using it in driving a step-up transformer which is wound to produce 220 - 240VAC at the frequency of 50Hz suitable for use.

The method proposed in this research involves the incorporation of ferrite transformers and the Insulated-Gate Bipolar Transistors (IGBTs). Ferrite transformers are those with ferrite core which is a type of magnetic core made of ferrite on which the windings of electric transformers and other

wound components such as inductors are formed. It is used for its properties of high magnetic permeability coupled with low electrical conductivity (which helps prevent eddy currents). Because of their comparatively low losses at high frequencies, they are extensively used in the cores of RF transformers and inductors in applications such as Switched-Mode Power (SMP).

Justification

As the world clamors for lower carbon emission and mitigation of climate change, various institutions and government agencies, the oil and gas industry giants etc., are now diversifying into a low carbon regime and investing in renewable energy utilization. There is heavy dependence on power generation from fossil fuel all over the world, while little attention is paid to the potentials of renewable sources like wind, biofuel, solar etc. Most homes and government institutions like ours lack steady power supply, as such, many have resorted to independent power generations schemes using low to high power generating plants and small-scale solar systems. Output power of these generating sets which are square waves in nature, are generally not good enough because of their eddy current losses for household appliances like electric fans, air conditioner systems, refrigerators, etc. Also, inductive loads like electric fans, air conditioning systems, refrigerators etc., do not function effectively due to excessive losses like switching losses in the drive signals and copper and eddy current losses in the transformers that they impose on power converting circuits. These appliances are significantly dominant in our homes and offices, therefore limiting dependence on solar power supply systems. Hence, it has become imperative to carryout research into developing new methods of constructing an intelligent power converter that effectively compensates for the high losses imposed by inductive loads and produces a pure sine wave, like that obtainable from our day-to-day electricity generators.

Statement of Task

The specific objectives of this research are as follows:

1. To design a $48V_{DC}$ to $220V_{AC}$ signal converting circuit with ferrite transformer and IGBTs using computer packages.
2. To design a network of sensors for system protection and signal frequency, voltage and current measurements.
3. To design a microcontroller circuit that utilizes the sensor outputs through feedback for various control algorithms.
4. To simulate the designed circuits with various signal oscillators until a pure sine wave is achieved.

Review of Existing Prototype

In this research, the existing prototype that was modified has the following specifications.

- Input voltage – 12Vdc
- Output voltage – 210Vac
- Output power – 450W
- Output signal waveform – modified sine wave

The results from the tests carried out on the prototype revealed significant power losses as result of the output waveform and quality of ferrite transformer used for the construction. Overall, this research is targeted at improving the capability of the existing prototype to produce a pure sine wave, higher power output that is usable for several electrical appliances and to make intelligent decisions based on specified conditions.

REVIEW OF RELATED LITERATURE

Switched systems such as SMPS are a challenge to design since their models depend on whether a switch is opened or closed. R. D. Middlebrook from Caltech in 1977 published the models for DC-to-DC converters used today. Middlebrook averaged the circuit configurations for each switch state in a technique called state-space averaging. This simplification reduced two systems into one. The new model led to insightful design equations which helped the growth of SMPS. In the early 20th century, vacuum tubes began to be used as switches in inverter circuits (Gurdjian & Maxwell, 2000).

In modern inverter circuits, the DC power is connected to a transformer primary through the center tap of the primary winding. A switch is rapidly switched back and forth to allow current to flow following two alternate paths through one end of the primary winding and then the other. The alternation of the direction of current flow in the primary winding of the transformer produces an alternating current in the secondary winding. The electromechanical version of switching devices includes two stationary contacts and spring support moving contact. The current in the electromagnet is interrupted by the action of the switch so that the switch continually switched rapidly back and forth, this electromagnetic inverter switch called vibrator or buzzer was used in vacuum automobile radios. The latest inverter circuits have transistors, FETs, SCRs and other electronic switches incorporated in them because of their numerous advantages over electromagnetic switches. In more advanced designs based on the basic H-bridge topology two different fundamental control strategies called basic frequency-variable bridge converter and PWM control are employed for better signal conditioning in inverters (Kassakian, 1991).

THEORETICAL BACKGROUND OF POWER CONVERTERS

According to Austin (2010), an inverter performs the opposite operation of rectifier. In his work, he stated that "for inverter to perform this function there must exist the oscillator, MOSFET, Transistor and other electronic component." Hence, a typical power inverting system requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. Power inverters exist in the following categories based on their output waveforms.

- Square wave converters
- Modified sine wave converters
- Sine wave converters

According to Barnes (2003), a square wave inverter is a type of inverter that is designed for low sensitive applications such as lighting and heating. They further stated that square wave inverter output can produce humming when connected to audio equipment and is generally not suitable for sensitive electronics.

In considering the limitations of square wave and modified sine wave inverters, pure sine wave inverter remains the best and produces quality power to all electrical equipment connected to it. It equally has lesser distortion as compared to modified sine wave and square wave inverters. The historical evolution of the DC power converter utility systems, the research and development strides recorded are all evidence of the viability of power converters for renewable energy utility. The high frequency inverting system has been designed and developed to produce a nearly perfect sine wave that is essentially the same as utility supply grid power. The prospects of high

frequency inverters as a smooth, pure, noiseless, and less cost source of electrical energy supply are explored in this project.

As described in work of Manias (2016), basically a power converter, as the name implies, does not produce its own power but simply converts power from one form into another. A stable DC power source is therefore required for the operation of the converter and the effectiveness of a conversion system lies in its ability to compensate for losses and its final output waveform. A converter can produce a square wave, modified sine wave, pulsed sine wave, pulse width modulated wave (PWM) or pure sine wave depending on its circuitry. Common types of inverters produce square waves. One way to measure the purity of a sine wave is the use of total harmonic distortion (THD).

Square Wave and Modified Sine Wave

Square waveform is one of the simplest waveforms an inverter design can produce and is best suited to low-sensitivity applications such as lighting and heating. Square wave output can produce "humming" when connected to audio equipment and is generally unsuitable for sensitive electronics.

The modified sine wave inverters on the other hand produce output waveforms that is the sum of two square waves of which is phase shifted 90 degrees relative to the other. The result is three level waveforms with equal intervals of zero volts; peak positive volts; zero volts; peak negative volts and then zero volts. This sequence is repeated. The resultant wave very roughly resembles the shape of a sine wave. Most inexpensive consumer power inverters produce a modified sine wave rather than a pure sine wave. Switching states are developed for positive, negative and zero voltages. If the waveform is chosen to have its peak values for half of the cycle time, the peak voltage to rms voltage ratio is the same as for a sine wave. The DC bus voltage may be actively regulated, or the "on" and "off" times can be modified to maintain the same rms value output up to the DC bus voltage to compensate for DC bus voltage variations (Manias, 2016).

As in the work of Shaaban, Thomas & Mostafa (2017), the ratio of on to off time can be adjusted to vary the rms voltage while maintaining a constant frequency with a common technique called PWM. The generated gate pulses are given to each switch in accordance with the developed pattern to obtain the desired output. Harmonic spectrum in the output depends on the width of the pulses and the modulation frequency. According to Manias (2016), it can be shown that the minimum distortion of a three-level waveform is reached when the pulses extend over 130 degrees of the waveform, but the resulting voltage will still have about 30% THD, higher than commercial standards for grid-connected power sources.

Barnes (2003) stated that when operating induction motors, voltage harmonics are usually not of concern; however, harmonic distortion in the current waveform introduces additional heating and can produce pulsating torques. Numerous kinds of electric equipment will operate quite well on modified sine wave power converter devices, especially loads that are resistive in nature such as traditional incandescent light bulbs. Appliances with a SMPS operate almost entirely without problems, but if the item has a mains transformer, this can overheat depending on how marginally it is rated. However, the load may operate less efficiently owing to the harmonics associated with a modified sine wave and produce a humming noise during operation. Most AC motors will run on modified sine wave inverters with an efficiency reduction of about 20% owing to the harmonic content. However, they may be quite noisy.

Pure Sine Wave

A power converter device which produces a multiple step sinusoidal AC waveform is referred to as a sine wave inverter. To distinguish the converters more clearly with outputs of much less distortion than the modified sine wave which are three steps inverter designs, the manufacturers often use the phrase pure sine wave converter. From the findings of Taylor-Moon (2013), almost all consumer grade inverters that are sold as a "pure sine wave inverter" do not produce a smooth sine wave output. However, this is not critical for few electronic devices as they deal with the output quite well.

According to Akinwole (2018), in conditions where power converter devices substitute for a standard source of power, a perfect or pure sine wave output is desirable because many electrical products are engineered to work best with a sine wave AC power source. Sine wave inverters with more than three steps in the wave output are more complex and have significantly higher cost than a modified sine wave, with only three steps, or square wave (one step) types of the same power handling. SMPS devices, such as personal computers or DVD players, function on modified sine wave power.

Taylor-Moon (2013) stated that AC motors directly operated on non-sinusoidal power may produce extra heat, may have different speed-torque characteristics, or may produce more audible noise than when running on sinusoidal power. A more complex converter can use more than two voltages to form a multiple-stepped approximation to a sine wave and the step-up transformer can be a ferrite core transformer. These can further reduce voltage and current harmonics and THD compared to a converter using only alternating positive and negative pulses.

MATERIALS AND METHOD

The research method involves the study of various signal oscillation integrated circuits for the selection of a suitable IC for pure sine wave production, design and construction of ferrite transformers and the method of application of IGBTs for signal switching. The following sequence of activities will be employed:

1. The design and development of a power converter circuitry using new design techniques with PIC16F877A integrated circuits, ferrite transformer and IGBTs.
2. Simulation of the designed circuit to produce a pure sine wave.
3. Construction/implementation of the simulated circuit.
4. Testing/results analysis with computer packages; and
5. Fabrication of photovoltaic panel as input to the batteries.

The materials used in this design include 48V ferrite transformer, Irfp4110 MOSFETs, 22N60 IGBTs, Fr5408 fast recovery diodes, 450uf/400V polarized capacitors, PIC16F877A microcontroller, resistors, s8050 and s8550 BJTs, 12V/40A Relays, 7805 and 7812 fixed voltage regulators, etc.

The above components are wired to form the different units of the system.

The units of the system are shown in the block diagram below.

Block Diagram

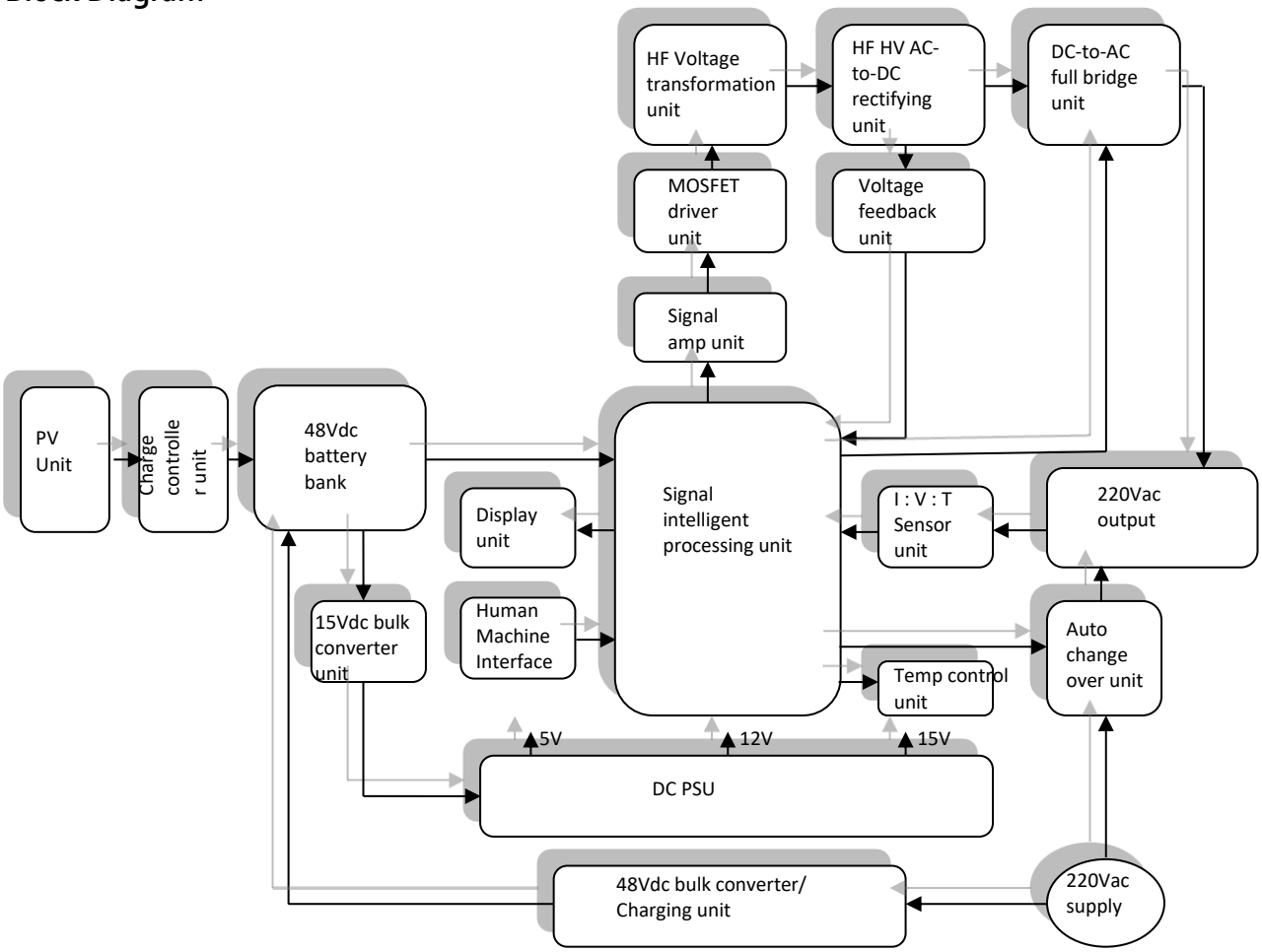


Figure 1 Block Diagram.

Circuit Diagram

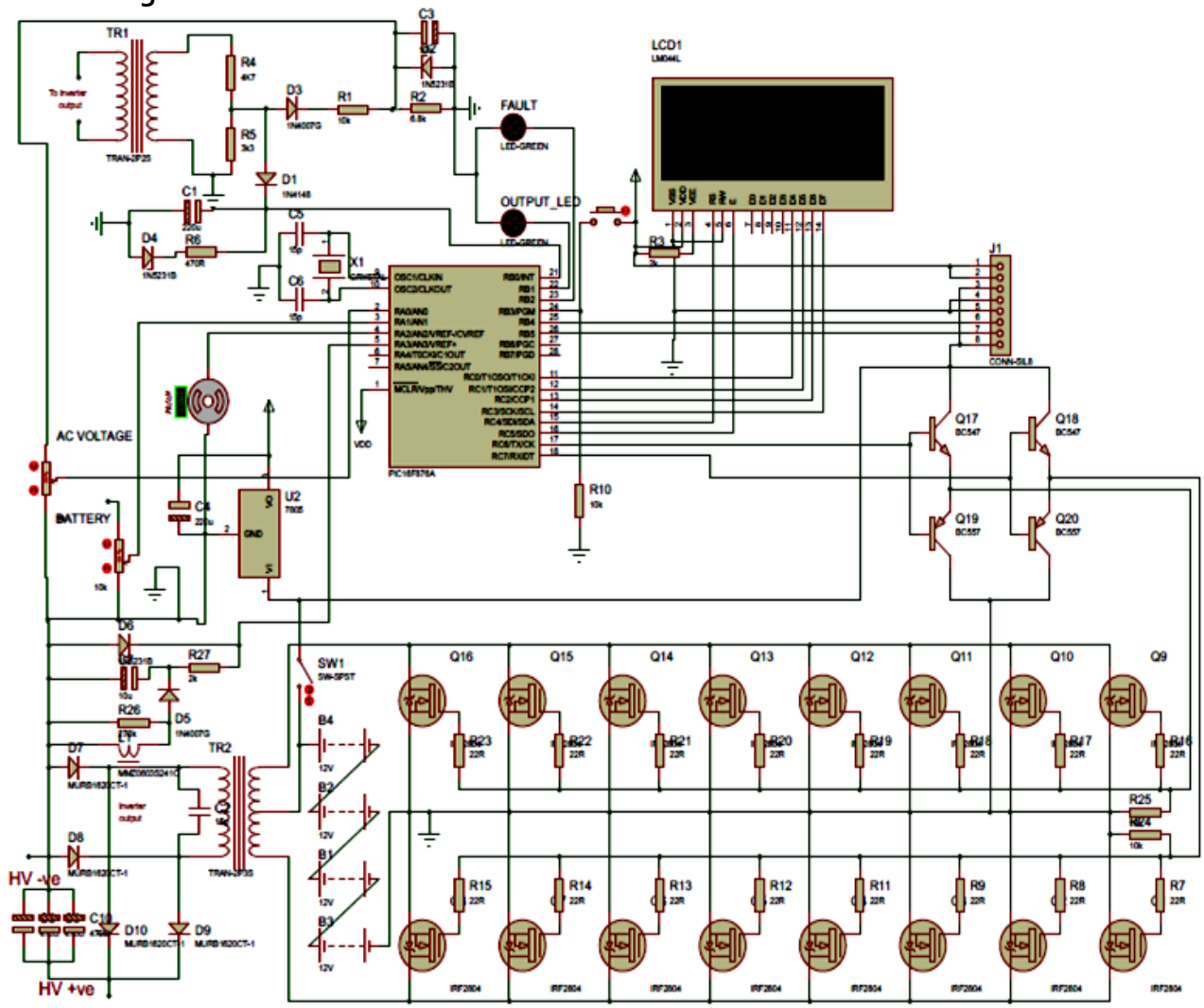


Figure 2: Block Diagram

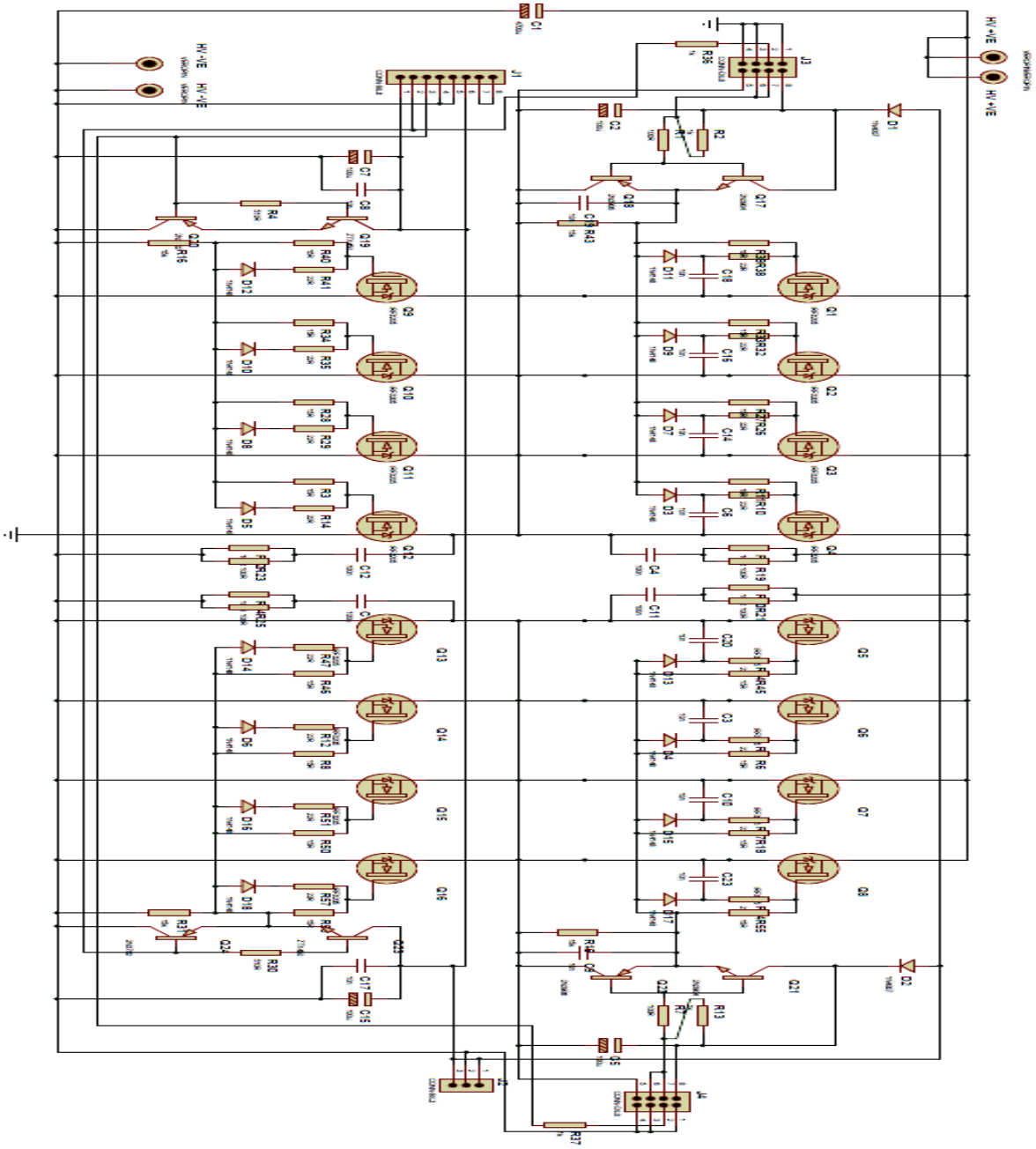


Figure 3: Circuit Diagram.

Design

There are many factors considered in the ferrite power transformer design.

Ferrite is an ideal core material for transformers, inverters, and inductors in the frequency range 20 kHz to 3 MHz, due to the combination of low core cost and low core losses. Ferrites may be used in the saturating mode for low power, low frequency operation (<50 watts and 10 kHz). Ferrite cores may also be used in flyback transformer designs, which offer low core cost, low circuit cost and high voltage capability. Powder cores (MPP, High Flux, Edge®, Kool $M\mu$, MAX, Kool $M\mu$ Hf, and $XFlux$ offer soft saturation, higher $B_{\max}$, and superior temperature stability and are often the best choice for minimum size and robust performance in power choke, inductor, and flyback applications.

EC, ETD AND EER CORES

These shapes combine the benefits of E cores and pot cores. Like E cores, they have a wide opening on each side. This provides ample space for the large wires used for low output voltage switched mode power supplies. It also increases the flow of air which keeps the assembly cooler. The center leg is round, like that of the pot core.

One of the advantages of the round center leg is that the winding has a shorter path length around it (11% shorter) than the wire around a square center leg with an equal area. This reduces the losses of the windings by 11% and enables the core to handle a higher output power. The round center leg eliminates the sharp bend in the wire that occurs with winding on a square center leg. The power handling capacity play significant role in the choice of the ferrite type and shape. Also taking into consideration to keep low the E-field and the kickback voltage, the primary and secondary sides of the ferrite transformer connection in fig 3.1 is adopted.

Core Material: Power magnetics *R, P, F, T* and *L* materials provide superior saturation, high temperature performance, low losses, and product consistency.

T material is used in this design for consistent performance over a wide temperature range and its applications which include Automotive, Electronic Lighting, Outdoor LCD Screens, Mobile Handheld Devices and AC adapters and chargers.

CORE SELECTION BY POWER HANDLING CAPACITY

The Power Chart characterizes the power handling capacity of each ferrite core based upon the frequency of operation, the circuit topology, the flux level selected, and the amount of power required by the circuit. If these four specifics are known, the core can be selected from the Power Chart on page 68.

Core Selection By W_aA_c Product

The power handling capacity of a transformer core can also be determined by its W_aA_c product, where W_a is the available core window area, and *Ac* is the effective core cross-sectional area. Using the equation shown below, calculate the W_aA_c product and then use the Area Product Distribution (W_aA_c Chart to select the appropriate core. W_aA_c = Product of window area and core area (cm4)

- Po = Power Out (watts)
- D_{cma} = Current Density (cir. mils/amp) Current density can be selected depending upon the amount of heat rise allowed. 750 cir. mils/amp is conservative; 500 cir. mils are aggressive.
- $B_{\max}$ = Flux Density (gauss) selected based upon frequency of operation. Above 20kHz, core losses increase. To operate ferrite cores at higher frequencies, it is necessary to operate the core flux levels lower than ± 2 kG. The Flux Density vs. Frequency chart shows the reduction in flux levels required to maintain 100 mW/cm^3 core losses at various frequencies, with a maximum temperature rise of 25°C for a typical power material, Magnetics P material.
- Ac = Core area in cm2 V = Voltage
- f = frequency (hertz) lp = Primary current
- Kt = Topology constant ls = Secondary current (for a space factor of 0.4)

- Np = Number of turns on the primary
- NS = Number of turns on the secondary

Topology Constants K_t

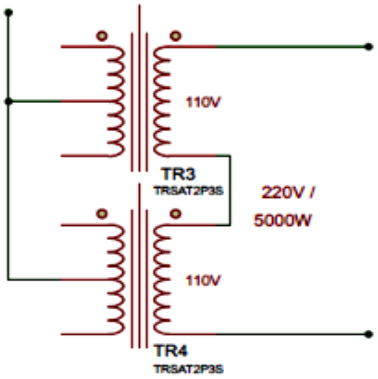
Forward converter = 0.0005	Push-Pull = 0.001(adopted)
Half-bridge = 0.0014	Full bridge = 0.0014
Flyback = 0.00033 (single winding)	Flyback = 0.00025 (multiple winding)

For individual cores, W_aA_c is listed in this catalog under "Magnetic Data."

The W_aA_c formula was obtained from derivations in Chapter 7 of A. I. Pressman's book, "Switching Power Supply Design. Choice of $B_{\max}$ at various frequencies, D_{cma} and alternative transformer temperature rise calculations were gotten from the data book.

$$W_aA_c = \frac{\mathbf{Po*Dcma}}{\boldsymbol{Kt*Bmax*F}}$$

For individual core values, W_aA_c can be found in the manufacturer's date book.



From the above circuit, one transformer will be 48V/110Vat 5000W.

Therefore, obtaining data corresponding of the size for the core design above from the standard chart as shown in Appendix xx, the formula applies in evaluating the primary turns of the transformer

$$N_p = \frac{V_p \times 10^3}{48A_{cf}}$$

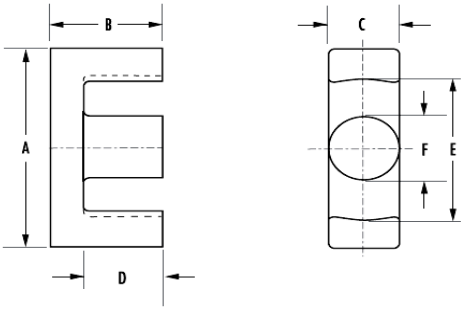
Np = 60 *10^{e8}/ (4*1800*31.6*60000) = 9.6T.

Approximately 10T per 48V at the primary of the transformer and 20T for the complete push-pull circuit.

$$N_s = \frac{V_s \times}{V_p} N_p$$

On the secondary turns, Ns = (120*10)/48 = 25T

Ferrite Core Size:



A=48mm; B =18mm; C=17.6mm; D=11.45mm; E=36.8mm; F=17.6mm

$$N_p = \frac{V_p \times 10^3}{48A_{cf}} \quad ; N_s = \frac{V_s \times}{V_p} N_p \; ; \; I_p = \frac{P_{in}}{V_{in}}, \; I_s = \frac{P_{out}}{V_{out}}$$

Transformer Design

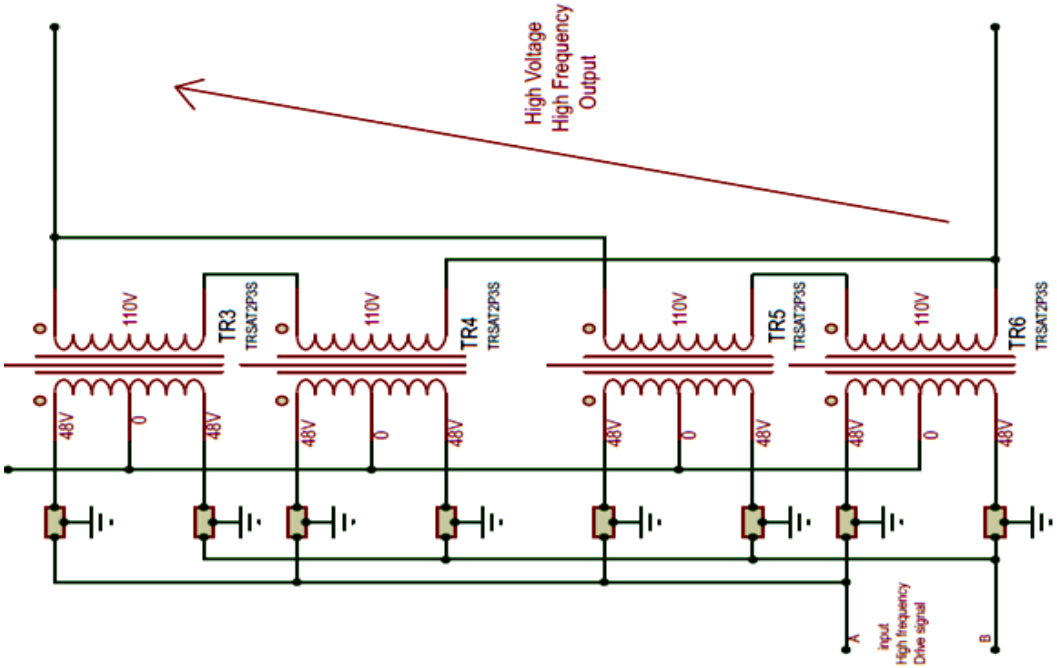


Figure 3: Transformer Design Diagram

Once a core is chosen, the calculation of primary and secondary turns and wire size is readily accomplished.

$$KW_a = N_p A_{wp} + N_s A_{ws}$$

Where:

- A_{wp} = primary wire area Aws = secondary wire area
- Assume K = 0.6 for E-U-I cores
- Assume $N_p A_{wp}$ = 1.1 $N_s A_{ws}$ to allow for losses and feedback winding

$$efficiencye = \frac{P_{out}}{V_{out}} = \frac{P_{out}}{P_{out} + wireloses + coreloss}$$

$$Voltage\,\mathrm{Re}ulation(\%) = \frac{V_{noload} - V_{fullooa}}{V_{fullload}} \times 100$$

Principle of Operation

The entire physical design of the intelligent converter is built around a microcontroller PIC16f877A. The microcontroller, which is the key component in the design, forms the signal processing unit of the system. According to the instruction written (in language) and programmed to the ROM of the microcontroller, the controller generates signals suitable for the High-Frequency (60KHz) ferrite driving circuit and for the full-bridge inverting circuit. The PIC microcontroller in the signal processing unit also receives signals from the current transformer, LM35 temperature sensor and the potential divider circuit used in calibrating the 48V battery voltage and the 220Vac output voltage in the system. The signals received are processed, tested against the acceptable safe values based on the programmed instructions embedded in the microcontroller. The system therefore converts 48Vdc power from the Battery bank at high frequency 305Vdc and then to 220Vac|50Hz before the monitored power is switched to the load. The logical implementation code for the intelligent converter using C programming language is shown below.

TEST, RESULTS AND DISCUSSION

The technical analysis of this system requires a series of tests from the different stages of the system and the corresponding results. The following tests were carried out:

After the circuit design and drafting using the PROTEUS design software, the firmware for the Pic16F877A microcontroller, written in C-programming using the MPLAB integrated Development Environment (IDE), and compiled. This generates an HEX file, and the file is programmed into the microcontroller IC using the TOPWIN universal programmer.

Test /Responses

Proteus System Configuration:

- Power supply to the microcontroller stage: 5V
- Quartz crystal: 20Mhz

Test 1: Visual Simulation

Procedure: Press the play/simulate icon on the proteus simulation environment after loading the *cof/Hex* file into microcontroller IC.

Responses:

- oscillation frequency: 50Hz
- signal waveform: see fig xx below.
- system temperature: 28.0°c
- load current:0.0A
- battery voltage:49.5V

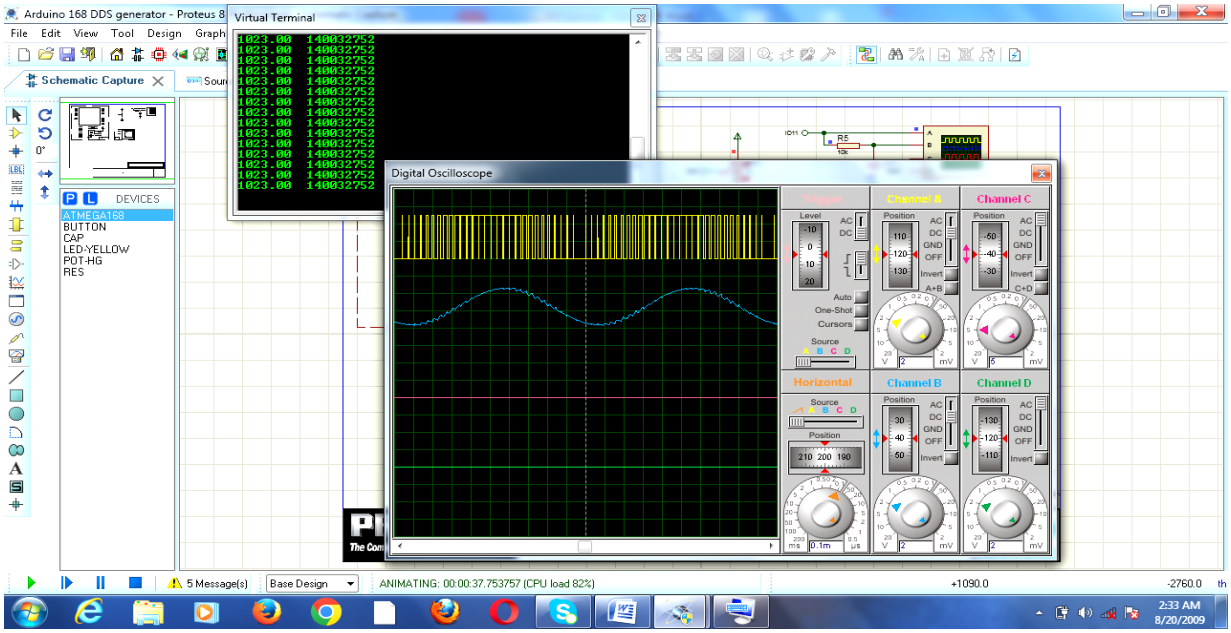


Figure 4: Simulation and Result

Test 2: Bread-Boarding

Procedures: The Hex file of the compiled programmed is written to the Pic16f877A microcontroller using a universal (TOPWIN) programmer, then the circuit components were mounted on a solderless breadboard following the designed circuit diagram.

Responses:

Using the oscilloscope and other measuring instruments the operating values were tested against the simulated values.

- oscillation
- frequency: 50Hz
- system temperature: 28.00c
- load current:0.0
- battery voltage:49.5V

Test 3: Overall system Test/ Implementation

The figure below (fig 5) shows the wiring diagram of the complete system setup.

Test 4: Stare-Up/ No-Load Test

Procedure: the system is set up as shown in the diagram below and the power switch is turned on.

System Response on No-Load							
DC(Battery) Input voltage (V)	AC (output) voltage (V)	Frequency (Hertz)	System Temperature (°C)	Load current (A)	Power switch state	System fan state	Buzzer
49.6	220V	50Hz	31.7	0.0A	ON	Off	Off

Dummy loads	Power switch state	DC(Battery) Input voltage:	AC (output)	Frequency	Load current (A)	Temperature	System fan state	Buzzer status	System response/ status

		(constant)	voltage (V)						
Load at 20%	ON	48Vdc	219	50Hz	9.3A	39.1°C	Off	Off	normal
Load at 40%	ON	48Vdc	219	50Hz	19.1	44.8°C	ON	Off	normal
Load at 60%	ON	48Vdc	219	50Hz	30.8	50.5°C	ON	Off	normal
Load at 80%	ON	48Vdc	217	50Hz	38.6A	59.3°C	ON	Off	normal
Load at 100%	ON	47.2Vdc	221	50Hz	48.9A	78.7°C	ON	beep	warning
Load above 100%	ON	48Vdc	0.0V	**0Hz**	-	83.2°C	ON	Steady ON	Fault

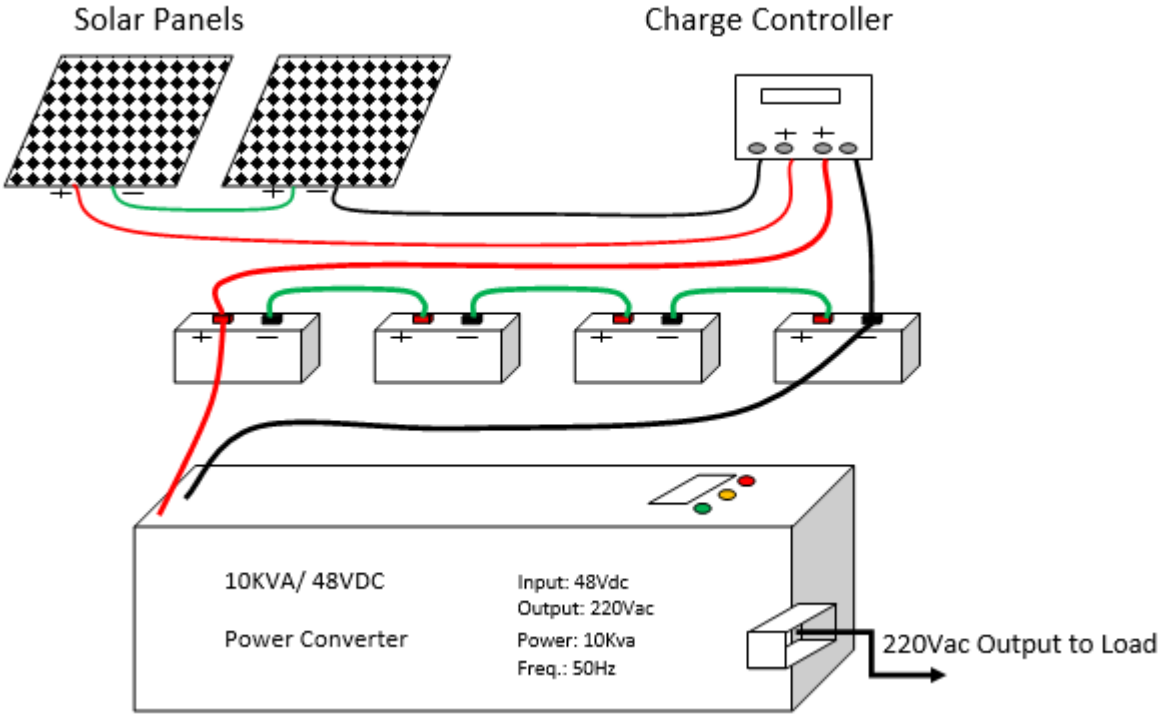


Figure 5: Final wiring diagram of system set up.

CONCLUSION

In conclusion, ferrite transformer-based converters play a pivotal role in advancing renewable energy applications. Their efficiency, compact design, and ability to operate at high frequencies make them well-suited for various renewable energy systems. As we strive for sustainable energy solutions, the utilization of ferrite transformers contributes to the overall effectiveness and viability of renewable energy converters, fostering a cleaner and more environmentally friendly energy landscape.

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Fixed Point in Finite Neutrosophic Topological Metric Space

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Abstract:
Briefly, neutrosophy is a new branch of philosophy which studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra. It relates to a general form of logic in which each proposition has separate values for truth, falsehood, and indeterminacy. This was formally discovered by Florentin Smarandache. For instance, the Neutrosophic sets (NS) have a significant role for clustering, denoising, segmentation, and classification in numerous medical image-processing's as well as their general applications. Motivated by the above, in this paper, we show that if Y (I) is a complete neutrosophic metric space in which the function f is a contracting mapping on the neutrosophic metric space Y (I), then, there exists one and only one point v in Y (I) such that f (v) = v

Keywords: Neutrosophic metric space, neutrosophic Euclidean space, contracting mapping, fixed point, Cauchy sequence, continuity

INTRODUCTION

In the recent years many articles on continuity in neutrosophic topological spaces have been studied. We implore our esteemed readers to consult our references (M. Parimala, et al, 2017, 2019 P. Mani etal 2018, A.A. Salama et al 2012, 2014, and B.C. Tripathy et al, 2013, 2014) for further details. In (B. C. Pal, et al, 2022), the authors introduced the notion of continuity via neutrosophic minimal structure space in a paper titled on continuity in minimal structure neutrosophic topological space. Clarification was also made on the notion of product minimal space in neutrosophic topological space. Investigations were thus made of some different basic properties of N_m-continuity in neutrosophic minimal structure space, such as composition of Nm-continuous functions, product of Nm-continuous functions in product neutrosophic minimal structure space. Our focus in this paper is to consider the fixed point in finite neutrosophic topological complete metric space.

The notions of neutrosophy, neutrosophic algebraic structures, neutrosophic duplet and neutrosophic triplet were introduced by Florentin Smarandache (Smarandache, 1998). On refined neutrosophic algebraic structures and in particular the neutrosophic groups, several developments were introduced by Agboola Adesina (Agboola, 2015). After the successful feat, many researchers have as well tried to establish and studied further more on the refined neutrosophic algebraic structures. (Agboola etal, 2020). Further studies on refined neutrosophic rings and refined neutrosophic subrings, their presentations and fundamental were also worked upon. Also, Agboola, in his paper (Agboola, 2020) has studied the refined neutrosophic quotient groups, where more properties of refined neutrosophic groups were presented and it was shown that the classical isomorphism theorems of groups do not hold in the refined neutrosophic groups. The existence of classical morphisms between refined neutrosophic groups G (I1; I2) and neutrosophic groups G(I) were established. The readers can as well consult (Agboola et al, 2011,

2012; Bera et al, 2017; Smarandache et al, 2006, 2013, 2022 and seymour lipschutz, 1965) in order to have detailed knowledge concerning the refined neutrosophic logic, neutrosophic groups, refined neutrosophic groups and neutrosophy, in general.

PRELIMINARIES

Definition 2.1. (Agboola, 2020)
Suppose that $(X\ (I_1; I_2); +; .)$ is any refined neutrosophic algebraic structure. Here, + and. are ordinary addition and multiplication respectively. Then I_1 and I_2 are the split components of the indeterminacy factor I that is $I = \alpha_1 I_1 + \alpha_2 I_2$ with $\alpha_i \in C; i = 1; 2$.

Definition 2.2. (Agboola, 2020)
Suppose that $(G; *)$ is any group. Then, the couple $(G\ (I_1; I_2); *)$ can be referred to as the refined neutrosophic group. Furthermore, this group can be said to be generated by G, I_1 and I_2. Hence, $(G\ (I_1; I_2); *)$ is said to be commutative if $\forall x; y \in G\ (I_1; I_2)$, depicts that $x * y = y * x$. Otherwise, $(G\ (I_1; I_2); *)$ can be referred to as a non-commutative refined neutrosophic group.

Theorem 3.1 (Agboola, 2020)
(1) Every refined neutrosophic group is a semigroup but not agroup. (2) Every refined neutrosophic group contains a group.

Corollary 2.1. (Agboola, 2020)
Every refined neutrosophic group $(G\ (I_1; I_2); +)$ is a group.

Definition 2.3 (Agboola, 2020)
Let $(G\ (I_1; I_2); *)$ be a refined neutrosophic group and let $A\ (I_1; I_2)$ be a nonempty subset of $G\ (I_1; I_2)$. $A\ (I_1; I_2)$ is called a refined neutrosophic subgroup of $G\ (I_1; I_2)$ if $(A\ (I_1; I_2); *)$ is a refined neutrosophic group. It is essential that $A\ (I_1; I_2)$ contains a proper subset which is a group. Otherwise, $A\ (I_1; I_2)$ will be called a pseudo refined neutrosophic subgroup of $G\ (I_1; I_2)$.

Definition 2.4 (Agboola, 2020)
Let $H\ (I_1; I_2)$ be a refined neutrosophic subgroup of a refined neutrosophic group $(G\ (I_1; I_2);)$. Define $x = (a; bI_1; cI_2) \in G\ (I_1; I_2)$.

Theorem 2.2 (Agboola, 2020)
Let $(G\ (I_1; I_2); +)$ be a refined neutrosophic group and let $(G(I); +)$ be a neutrosophic group such that where $I = xI_1 + yI_2$ with $x; y \in C$. Let $\varphi: G\ (I_1; I_2) \longrightarrow G(I)$ be a mapping defined by $\phi\ ((a; xI_1; yI_2)) = (a; (x + y)\ I)\ \forall\ (a; xI_1; yI_2) \in (G\ (I_1; I_2)$ with $a; x; y \in G$: Then ϕ is a group homomorphism.

FIXED POINT IN FINITE NEUTROSOPHIC TOPOLOGICAL COMPLETE METRIC SPACE

Definition 3.1
Suppose that Y(I) is a neutrosophic metric space which involves a continuous mapping on Y(I) such that for every point in Y(I), there is a maintenance of contraction, then, the mapping f is continuous at each point in Y(I).

Definition 3.2
Suppose that Y(I) is a finite neutrosophic metric space. A neutrosophic function $f: Y(I) \longrightarrow Y(I)$ is called a contracting mapping provided there is a real number γ for which $0 \leq \gamma < 1$ such that for every $x, y \in Y(I), d(f(x), f(y)) \leq \gamma d(x, y) \leq d(x, y)$. The implication here, is that the

distance between the images of any two points is actually less than the distance between the points.

Proposition 3.1
Let Y (I) be a metric space and f: $Y\ (I) \rightarrow Y\ (I)$, a contracting mapping on Y (I) and let f be a contracting map on a complete metric space Y (I), say $d\ (f\ (x), f\ (y)) \leq \beta d\ (x, y), 0 \leq \beta < 1$ There exists one and only one point p in Y (I) such that $f\ (v) = v$.

Proof
Let a_o be any point in Y (I). Set $a_1 = f\ (a_0), a_2 = f\ (a_1) = f_{\ 2}(a_0), \cdots, a_n = f\ (a_n - 1) = f_n(a_0), \cdots$ Claim: $\langle a_1, a_2, \cdots \rangle$ is a Cauchy sequence. It should be properly noted here that $d(f^{s+t}(a_o), f^t(a_o)) \leq \beta d(f^{s+t-1}\ (a_o), f^t - 1(a_0)) \leq \cdots \leq \beta^t d(f^s(a_0), a_0) \leq \beta^t [d\ (a_0, f\ (a_0)) + d(f\ (a_0), f^{\ 2}(a_0)) + \cdots + d(f^{s-1}(a_0), f^s(a_0))$ But then, $d(f^{i+1}(a_0), f^i(a_0)) \leq \beta^i d(f\ (a_0), a_0)$,

so, we have, $d(f^{s+t}(a_0), f^t(a_0)) \leq \beta^t d(f\ (a_0), a_0)(1 + \beta + \beta^2 + + \beta^{s-1}) \leq \beta^t d\ (f\ (a_0), a_0)\ [1/6]$.

This is because $(1 + \beta + \beta^2 + \cdots + \beta^{s-1}) \leq 1/6$

Now, if we let e > o and set

$$\alpha = \begin{cases} e(1 - \beta) if\ d(f(a_o),\ a_o) = 0 \\ \text{and} \\ \frac{e(1-\beta)}{d(f(a_o), a_o)}\ if\ d(f(a_o),\ a_o) \neq 0 \end{cases}$$

Now, since β > o, there exists $n_o \in N$ such $a_{no} < \beta$. Hence, if $r \geq s > n_0$, then $d\ (a_s, a_r) \leq \beta_s$ [1/6] $d\ (f(a_0), a_0) < d$ [1/6] $d\ (f(a_0), a_0) \leq e$

And so $\langle a_n \rangle$ is a Cauchy sequence. Now, $Y\ (I)$ is complete and so $\langle a_n \rangle$ converges to a point p in Y (I) say. We then show here, that $f\ (v) = v$, for f is continuous and hence sequentially continuous, so,

$$f\ (v) = f\ (\lim_{\infty \rightarrow n} a_n) = \lim_{\infty \rightarrow n} f\ (a_n) = \lim_{\infty \rightarrow n} a_{n+1} = v$$

Finally, we show here that p is unique

So, suppose that $f(v) = v$ and $f(q) = q$ then $d\ (p, q) = d\ (f(v), f^i(q)) \leq \theta d\ (p, q)$ But then $\theta < 1$, hence $d\ (p, q) = o$. That is $p = q$.

Let $Y\ (I)$ be a metric space and let f: $Y\ (I) \rightarrow Y\ (I)$ be a continuous mapping on $Y\ (I)$ i.e., there exists $\gamma \in R$, $o \leq \gamma < 1$, such that for every $a, b \in Y$, $d\ (f(a), f(b)) \leq \gamma d\ (p, q)$. f is continuous at each point $y_o \in Y\ (I)$.

For let $e > o$ be given, then $d\ (y, y_o) < e, \Rightarrow d\ (f(y), f(y_o)) \leq \gamma d(y, y_o) \leq \gamma e < e$. Therefore, f is continuous.

Instances

If f is a function on the neutrosophic Euclidean $2-space$, R^2 that is if $f: R^2 \longrightarrow R^2$ is defined by $f(u) = ½\ u$, then, f is contracting.

Applications

If Y(I) happens to be a complete neutrosophic metric space then this particular result is well applicable in various mathematical analysis.

CONCLUSION

We have been able to successfully show the contracting property as well as the uniqueness of the given fixed point in every complete neutrosophic metric space

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CONFLICTS OF INTEREST

The author declares that there is no competing of interests

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Quality Evaluation of Jam Produced from Fresh and Dried Roselle Calyces (*Hibiscus sabdariffa*)

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Abstract:
The quality evaluation of jam produced from fresh and dried roselle calyces was investigated. Jams were produced from fresh and dried roselle calyces. The jam samples were subjected to physico-chemical, and sensory analysis using standard methods. The result of the physico-chemical properties of jams produced from fresh and dried roselle calyces indicated no significant (P>0.05) differences in ash (0.77-0.71), moisture (32.71-29.26) and TTA (1.73-1.82) except for Vitamin C (27.79-14.49) where significant (P<0.05) difference was observed. The result of the sensory attributes of jam produced from fresh and dried roselle calyces showed no significant (P>0.05) differences in their level of preferences and acceptability. The appearance, aroma, taste, mouthfeel and overall acceptability ranged between 7.93-8.47, 7.53-773, 7.07-7.73, 7.73-7.80 and 7.60-8.07 for jam from fresh and dried roselle calyces, respectively. It was therefore deduced that roselle jams prepared from either fresh or dried calyces are acceptable for consumption. The study recommended that either fresh or dried roselle calyces could be used in the production of jam due to their nutritional values. Similarly, the study advised that roselle jam be processed from the fresh calyx so as to reduce the rate of Vitamin C loss.

INTRODUCTION

Background of the Study

Fruits and vegetables are important in human nutrition and commerce; however, they are seasonal and highly perishable and need to be processed into more stable forms such as jams, jellies and juice so as to derive their maximum benefits (Ashaye and Adeleke, 2019).

Jam is food that is cooked using the meat/juice of fruits or vegetables which are then converted into jelly-like form. In general, jam is made using only one type of fruit with the characteristics of a good jam is to have a soft and even texture, favorable color and good fruit taste (Berolzheimer, 2019). Jam production can use various types of fruit, but in general the fruit that is used contains pectin. Pectin is a sugar/polysaccharide compound that makes jam to have a soft but thick texture. Jam is an intermediate moisture (semi-solid) food product prepared by cooking of fruits with sugar (with/without added pectin and acid) to increase the total soluble solids (TSS) content to >65% (Codex Stan-79, 1981). Fruits have mostly enough acidity and pectin content (extracted during cooking), contributing to the texture development in jam. It tends to apprehend shape, but normally less firm compared to jelly. Jam has prolonged shelf life so that it can be available round the year. Production of jam requires ingredients (fruit pulp, acid, pectin and sugar) of correct quantities for having desired finished product. Raw material quality and process of manufacturing are the exponents to the quality of finished goods (Nindo *et al.*, 2015).

Roselle (*Hibiscus sabdariffa* L) is a member of the family Malvaceae to which okra, cotton and kenaf belong. Both the leaves and the fleshy base of the flower (the calyx) are employed in the preparation of soups and sauces. Roselle calyx is a cheap source of vegetable protein, fat and minerals therefore its consumption should be encouraged in order to avoid nutrition deficiency diseases such as night blindness, scurvy and rickets (Babalola *et al*., 2011).

High sugar content is adopted in Jam making in order to suppress microbial growth, sweeten the product, help set the pectin, and make the product glisten (Kataria *et al*., 2016), while the pectin precipitates and helps form a matrix gel with the fruit content and sugar to yield a mixture that has a shelf-life of over 6-12 months. The act and art of jam making is an interesting process that helps reduce post-harvest losses that are often associated with fresh fruits. This research work was therefore geared towards evaluating the quality of jam produced from fresh and dried roselle calyces.

Justification of the Study

In Nigeria, the utilization of fresh Roselle (*Hibiscus sabdariffa* L) is not popular except in the preparation of sorrel drink popularly known as 'zobo' drink. Production of jam using fresh and dried roselle would not only improve utilization of the unpopular plant but as well enhance the nutritional qualities at the same time providing tasty jam products.

Objectives of the Study

Broad Objective:

The broad objective of the study was to evaluate the quality of jam produced from fresh and dried roselle calyces.

Specific Objectives:

The specific objectives of the study were to;

1. Formulate jam from fresh and dry roselle calyces
2. Determine the physico-chemical properties of jam produced from fresh and dried roselle calyces.
3. Evaluate the sensory properties of jam produced from fresh and dried roselle calyces.

LITERATURE REVIEW

Jam

Jam is defined as an intermediate moisture food obtained upon boiling fruit pulp with sufficient quantity of sugar (sucrose), pectin, acid, and other ingredients such as preservatives, colouring agents and flavouring materials to a gel like consistency which is firm enough to hold the fruits tissues in position (Khan *et al*., 2015). As per FSSAI Standards (2012), Jam should contain more than 68.5% total soluble solid (TSS) content and fruit pulp content should be at least 45%. Usually, jams have been prepared with high amount of sugars, mainly sucrose (WHO/FAO, 2013). However, consumption of sucrose in large quantity has been associated with adverse effects on health, such as obesity, diabetes, cardiovascular diseases and hypertension (Mendonca *et al*., 2015). Therefore, the uses of low-calorie sweeteners for replacement now-a-days, natural sweeteners are trapping more attention as the replacer of sugar.

Fruits are high in sugar content and rich in vitamins A and C. It plays a critical role in human diet and nutrition. Due to the perishable nature and season availability, about 16 to 72 percent of fruits are gone to waste due to spoilage because of poor storage conditions and transportation

conditions. Hence, preservation of fruit is required to reduce fruit wastage. Fruit jam is a food product made from whole fruit that is crushed or cut into pieces and then heated with sugar and water until it reaches the "setting" or "jelling" point, which is achieved through natural or added pectin. Lawrence and Franklin (2015) defined the Fruit Jams as a thick, sweet spread made by crushing/chopped fruits with sugar, pectin, water, and cooking. Bloomfield, in 1998, defined jam as a mixture of fruits and sweeting agents brought to a gelled consistency with or without a permitted ingredient.

The fruit jam should have good constancy to spread quickly and should be firm enough to not flow like fluid. The fruit jam should contribute at least 68.5% of total soluble solids, and the fruit should contribute at least 45%. The study shows that 27% of essential nutrients are found in the fruit jam during the analysis using the AOAC (Association of Official Analytical Chemists), (2003) method. The fruits jam provides a good source of carbohydrates and energy, and the sugar content lowers the water activity and increases shelf life. Fruit jams are deficient in fatty acid content (Sandrou and Arvanitoyannis, 2010).

There is a wide variety of fruits jams like strawberry jam, raspberry jam, wild plum jam, strawberry watermelon jam, mango jam, mixed fruit jam, among others. It is used to make different food products like pancakes, ice cream, toast, among other meals (Mishra *et al*., 2012).

Global Production of Food Spread

Food spreads had a global market volume of 46.6 million tonnes and a value of US$56 billion in 2016 (Euro monitor International, 2017). Margarine is the most popular product (5.2 million tonnes), followed by butter (3.2 million tonnes), spreadable process cheese (2.1 million tonnes), nut and seed spreads (688 million tonnes), and yeast extracts (16.2 K tonnes). However, the butter category has the highest retail value (US$17.5 billion), followed by processed cheese (US$15.2 billion), margarine and spreads (US$14.3 billion), nut and seed spreads (US$3.4 billion), and yeast extracts (US$0.2 billion). Since 2011, the overall volume and retail value have decreased by 8.9% and 9.7%, respectively, throughout the entire category (Johnson, 2019). The drop in total volume is attributable to the margarine and spreads (4.5 per cent) and yeast extract (6.6 per cent) categories. All categories are on the decline in retail value, except for nut and seed spreads (4.1 per cent). The US (642.9 million tonnes), Brazil (581.6 million tonnes), Germany (364.7 million tonnes), and the United Kingdom (364.7 million tonnes) have the most significant overall quantities of margarine and spreads (Beeren *et al*., 2019).

Food spreads cover a wide range of products, including sweet fruit-based, savory, and sweet fruit-based spreads. Nutbased, dairy-based, and savory yeast extract-based alternatives are also available. Natural sodium is present in many ingredients (for example, fruit, vegetables, nuts, and milk), but its contribution to the sodium concentration of the product as a whole is quite little. Take salt, for instance, each 100 g of strawberry, peanuts, and milk has 1, 18, and 49 mg of salt, respectively (United States Department of Agriculture, 2016). There miht be changes across crop years, as well as between species and types, because they are agricultural crops. Feeding methods, this might have a slight impact on the finished product's salt content. The other substances would provide the majority of the sodium, with salt being the most prevalent. Salt makes up the majority of the sodium components in the fruit-based and yeast groups. Other additives, such as stabilisers, could be used to keep the fat, fats, ground nuts, and water in an emulsion form in nut and dairy spreads and cream cheeses. All but butter could be found in the dairy-based kind (e.g., cream cheese).

Classification of Spreads

Different types of spreads are: Margarine, butter spreads, cream spreads, cheese spreads, paneer spreads, chakka spreads and yoghurt spreads. Fat spreads like margarine, blended fats and butter spreads are water–in-oil type emulsions whereas others are oil-in-water type emulsions. Different categories of spreads are presented in Table 2.

Table 1: Volume of spread used by different countries

S/No	Country	Volume (Million tonnes)
1	United States	642.9
2	Brazil	581. 6
3	Germany	364.7
4	United Kingdom	303. 3

Source: Beeren *et al*. (2019)

Table 2: Types and classification of food spreads

Based on source of ingredients			Based on functional attributes	
Dairy spreads: Only milk fat is used			Fortified (fatty acids, vitamins, antioxidants etc.)	
Non-dairy spreads: Vegetable fat with or without milk fat used as a source of fat				
Composite spreads: Dairy ingredients + Nondairy ingredients			Probiotic	
World Health Organization & International Diabetes Federation (WHO/IDF)		**Food Safety and Standards Authority of India (FSSAI)**		**Food and Agriculture Organization (FAO)**
Dairy spread	Normal: 62 – 80% fat; Reduced fat: 41–61% fat; Low fat: < 41% fat	Not more than 80% fat and not less than 40% fat by weight	Milk fat spread	Dairy spread: not less than 60% fat
Blended spread			Mixed fat spread	Reduced fat spread: 60–70% fat
Fat spread			Vegetable fat spread	Low fat spread: 40- 60% fat

Source: Supit *et al*. (2018)

Different types of fruit-based spread:

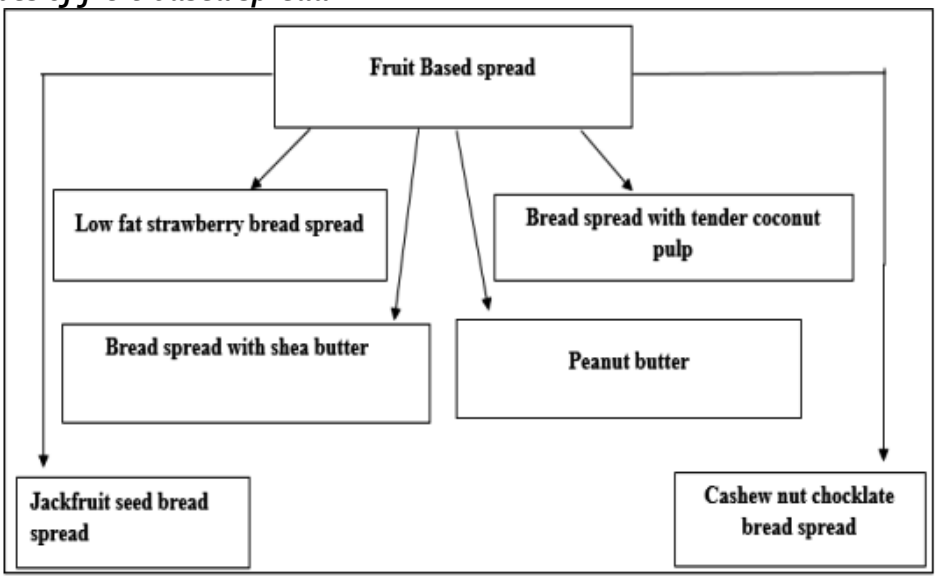

Figure 1: Different type of spread

Source: Supit *et al*. (2018)

Manufacturing Process of Fruits and Vegetable Spread

In general, production of spreads involves preparation of the water phase and fat phase, emulsion preparation, pasteurization, crystallization, filling and packaging, flow chart of which is shown in Figure 2.

General process of manufacture is: The aqueous phase consisting of water, salt, gums, thickeners, preservatives and water soluble colours is mixed thoroughly with fat phase consisting of oils, emulsifiers and fat soluble colours and the mix is pasteurized at 95°C for no hold. In the next holding tank, flavours are added, mixed and cooled using air blast coolers and finally packaged. The speed of agitation and time is very important in obtaining desirable consistency in *processed cheese spread* (PCS) (Cerníková *et al*., 2018). Samples produced using 3000 rpm were having significantly higher consistency in comparison with the *processed cheese spread* produced using lower agitation speeds (1000 and 1500 rpm). However, the firmness of the product increased during storage at about 6°C.

Manufacture of low-fat spread is a technological challenge. A good quality low fat spread can, however, be prepared if suitable emulsifiers and ingredients are used. Since higher levels of water content are available in low fat spreads, an appropriate stabilizer system is needed to impart the necessary stability in the crystallized product. Alginates, pectin and carrageenans have good water binding effect and give stable emulsions. Water-soluble flavours and colours are generally added. To prepare low fat spreads, the water phase and oil phase having the same temperature are to be mixed slowly to form a proper emulsion and avoid formation of high viscosity. Intensive mechanical treatment tends to build up a higher emulsion viscosity in very

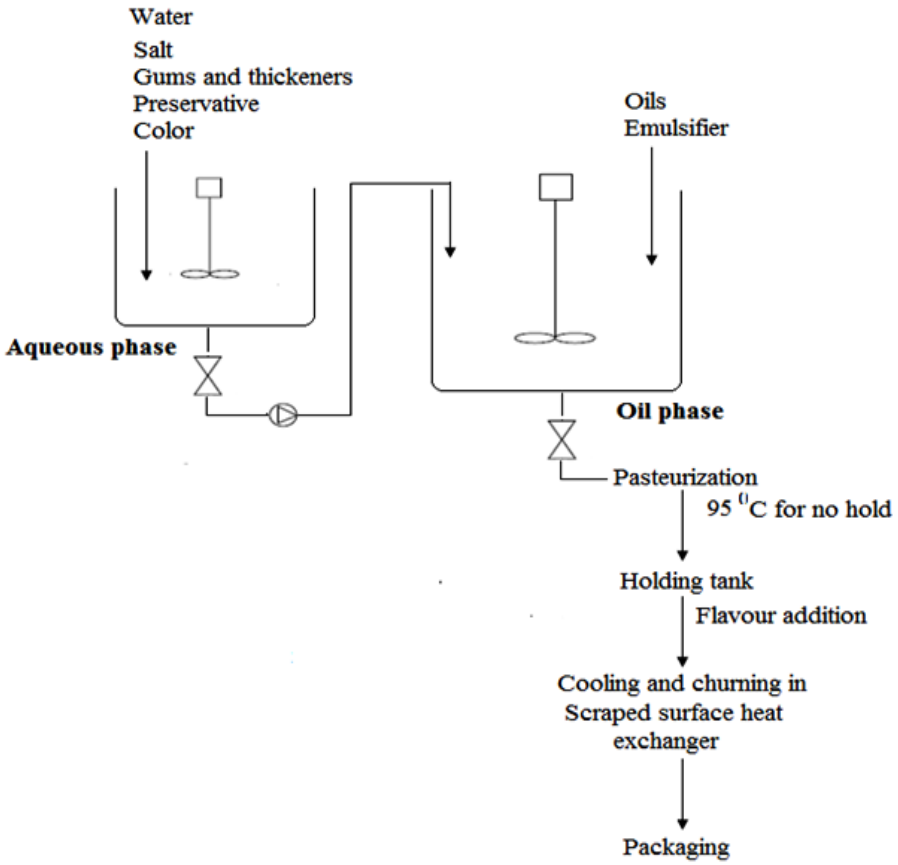

Figure 2: Schematic diagram of manufacture of vegetable fat spread

Source: Rao and Devaraja (2021)

low fat spreads, necessitating use of suitably designed stirrers to handle highly viscous emulsions. Anker stirrers function very well in the relatively high viscous emulsions. Storage of spread at a high temperature may render the product soft after cooling, while fast cooling may produce a brittle and more unstable low-fat spread. Low fat spreads should be stored at 15°C for 3-5 days before cooling to 5°C. Using storage (G',) and loss (G') moduli within the frequency of 01- 100 Hz in a rheometer, the effect of different agitation speeds and various holding times of the melt on the consistency of PCS having 35% dry matter and 40% fat in the dry matter, was examined by Cernikova *et al*. (2017). There was a continuous decrease in firmness of the samples in the first three minutes during holding. Thereafter, the firmness of the samples steadily increased from the third to the twentieth minute of holding time regardless of the speed of agitation tested. All the processed cheese samples showed an increase in firmness over 60 days of storage. To ensure homogeneity, the emulsion needs to be properly blended avoiding incorporation of air during emulsification. It is normally difficult to decrease the fat content to less than about 25% in a spread, if the water droplets have exactly the same size in a water-in-oil emulsion. By utilizing the combined benefits of different emulsifiers, it is, however, possible to create water droplets having different sizes and make the emulsion more closely packed. This also enables to produce 20 - 15% or even 10% fat spreads. Since the oil phase needs to cover a large number of water droplets, it is necessary to have more liquid oil in the fat composition of a low-fat spread than similar high fat spreads to preserve the smoothness. Presence of too much palm stearin may render a low-fat spread (10% fat) more unstable compared to palm oil probably due to more brittleness during and after production.

Bascuas *et al*. (2021) claimed that oleogels are viable and healthy alternatives to replace the saturated fat present in chocolate spreads and can be used to replace upto 50% coconut butter in the formulation. The authors designed chocolate spreads using oleogels with two oils (olive and sunflower), hydroxyl propyl methyl cellulose (HPMC) and xanthan gum (XG), as structuring agents. The oleogels conferred consistency to the spreads due to the network formed by HPMC and XG. This concept can have a potential application in dairy spreads. Corn milk, maltodextrin, citric acid and papain were used by Aini *et al*. (2019) to prepare an analogue of low-fat cheese spread containing about 7% fat.

Fruit Spread

Low Fat Strawberry Spread:

Strawberry is a popular fruit of the Rosaceae family. It is planted all across the world and holds a prominent position among little fruit plants. The very perishable fruit has a good flavor and is deep crimson in color with a distinctive form. It's high in vitamin C, sugar, organic acids like anthocyanin, phosphorus, iron, and other minerals and vitamins, and it has a fruity, sweet, and tangy flavor. Purees, juice concentrate, juice, jams, preserves, and rose red wine are all made using it. (Sharma *et al*., 2009) Strawberries (*Fragariax ananassa*) are one of the most popular fruits in the world, having a distinct and appealing flavor. The texture and presence of volatile chemicals are the two most important properties of ripe strawberries (Jiawei *et al*., 2019) Strawberry's high fiber, potassium, vitamin C, and folate levels are well known for their potential health advantages. Strawberries are also high in blood sugar-regulating dietary fibers (pectins, celluloses, among others.) as well as thyroid-supporting iodine. Strawberry fruits are high in sugars (mostly glucose and fructose, with little sucrose) and acids. Strawberry is an excellent source of vitamin C. Vitamin C and phenolic compounds have been shown to contribute to the antioxidant capacity of fruits by acting as oxygen radical scavengers and may have health benefits (Yildiz *et al*., 2014). Potassium (the most prevalent mineral), calcium, and magnesium are all abundant in strawberries. They're

also high in folate, omega-3 fatty acids, vitamin B6, vitamin K, and the energy-boosting vitamins B2 and B5 (Milivojevic *et al*., 2010) Ripe strawberries, on the other hand, are very perishable due to their smooth texture, rapid softening and respiration, and resistance to fungal infections and off-flavor development (Lara *et al*. 2014). For pulp processing, uniform red-colored, medium-sized, healthy fruits were chosen. The fruit sepals were manually removed and crushed using a Pulp-Homogenizer combination. After that, the pulp was put into sterilized glass bottles and pasteurized for 15 minutes at 100 °C. The homogenized pulp was then sieved at 1 mm in stainless steel. According to the approach described by, the pulp was treated and held for a longer amount of time (Bishnoi *et al*., 2016).

Powder Preparation:

Strawberry was purchased at a local market in Kolhapur and transported to the Department of Animal Sciences' laboratory. RCSM College of Agriculture, Kolhapur, Department of Animal Husbandry and Dairy Science the strawberries were cleaned under running water from a tap. The fruits were then blanched for 3 to 5 minutes in hot water. After blanching, the fruits were sliced into four pieces and dried for 18 hours at 55°C (Olubunmi *et al*., 2013) Using a kitchen mixer blender, the dried strawberry fruit pieces were ground into powder. A 1mm stainless steel sieve was used to filter the powder. For later usage, the sieved strawberry powder was wrapped in plastic bags and stored at room temperature. Except for boiling into the water for 3-5 minutes, the same procedure was followed for strawberries that had not been blanched.

Making A Low-Fat Spread with Cow Milk Ghee and Strawberry Jam:

In a planetary mixer, low-fat spread made from cow milk ghee was made according to a procedure described by Patange (2016). Before combining and emulsifying the fat and serum stages, they must be separately prepared and tempered. Ghee was heated to 50 °C before being combined with the emulsifier to make the fat phase. It was then rapidly cooled to 20 °C (rate of cooling, 12 °C/min) with continuous agitation in a cold water-bath (2.5 - 1 °C) and finally to 5 °C by quiescent holding in a refrigerator for an overnight duration. The chilled fat phase was then tempered at room temperature for 6 hours before usage to the blending temperature of 25 °C 1 °C.

The final product was tested for sensory factors such as colour and appearance, flavour, body and texture, spread ability, and general acceptability, according to the findings. It was concluded from this investigation that a reduced fat spread made with blanched powdered strawberry was the most acceptable.

Bread Spread with Tender Coconut Pulp:

The coconut palm (*Cocos nucifera* L), a palmaceae family member, is one of the world's most economically important trees. The various possible uses of this multi-purpose tree crop have earned it the nickname "tree of life." Coconut holds a unique place among the different horticulture crops grown throughout the universe due to its contributions to both the food and edible oil economies. Only about 50-55 percent of India's matured nuts are used for domestic culinary purposes as well as social and religious occasions, leaving the rest for processing into oil and various food products. Around 15% of the collected nuts are used at the tender nut stage for direct consumption as well as conversion into bottled beverages (Afrin *et al*., 2016). The raw materials that needed for this is tender coconuts aged 7-8 months were purchased from local stores, while fully ripened fruits were obtained from Thrissur, Kerala neighbourhoods. The flesh of the young coconut is a white albuminous endosperm that was chosen for the study because it is edible and tender. Tender coconut pulp was used as the substrate for the spread, which was

then combined with fruit extracts in three different quantities. Guava extracts in 75:25, 50:50, and 25:75 ratios from tender coconut pulp. Tender coconut pulp: 75:25, 50:50, and 25:75 extracts of jackfruit rind. Plantain extracts in 75:25, 50:50, and 25:75 ratios from tender coconut pulp (TCP). Three replications of the experiment were carried out in CRD. In an open pan, delicate coconut pulp and fruit extracts were combined in the desired ratio and heated continuously with the other ingredients. When the TSS reached 68-690 Brix, the heating was turned off and the liquid was poured into clean, sterilized, and dry glass bottles with a volume of 200 mL and sealed airtight. The bottles were then kept at room temperature for storage testing. For a period of six months, quality evaluations of the products were conducted at monthly intervals. A panel of ten judges conducted an organoleptic examination of the spread using a score card, and quality criteria such as appearance, color, flavor, texture, taste, and overall acceptability were scored using a nine-point hedonic scale. The findings of Afrin *et al*. (2016) demonstrate that various fruit extracts such as guava, plantain, and completely wasted jackfruit rind, as well as residual coconut pulp left in tender coconuts after intake of coconut water, can be used to make spread. The spread's physicochemical and organoleptic examination revealed that the items had a six-month shelf life when stored at ambient temperatures. When different textural characteristics such gel strength, adhesiveness, brittleness, and rupture strength were investigated, the generated spread was shown to have good textural features. At the conclusion of six months of storage, microorganisms were found, although these were within acceptable limits of above 6.5 on 9-point hedonic scale. The goods were ranked based on the scores they received for several organoleptic qualities. ST8 (50 percent TCP + 50 percent PE) received the greatest ranking in terms of spread, followed by ST3 (25 percent TCP+ 75 percent GE).

Bread Spread with Shea Butter:

Shea tree fruit is green in color and contains a fleshy edible pulp that is high in vitamins and minerals. It is highly sweet and includes 0.7-1.3 g of protein and 41.2 g of carbohydrates. In comparison to oranges, which have 50mg/100g of ascorbic acid, the fruit pulp has 196.1mg/100g. The iron and calcium content are comparable to that of raspberries (FAO, 1998). Sugar concentration ranges from 3-6 percent, with glucose, fructose, and sucrose being divided evenly. Shea butter is made in one of two ways. Traditional and chemical processes include hexane extraction, clay filtering, and refined shea butter as the final product (Davrieux *et al*., 2010). Shea butter is used as a foundation for therapeutic ointments, and its anti-inflammatory, emollient, and humectant effects have been reported. Shea butter is also used as a water proofing wax, in hair styling, and in candle production. It's also used to treat colds and the flu. It's also used by traditional African percussion instrument makers to help wood and leather ties last longer (Alander, 2004). Shea butter is used as a cooking oil in West Africa, particularly Ghana, Nigeria, and Togo (Olajide *et al*., 2010). It is edible and can be used in cooking, and the chocolate industry occasionally substitutes shea butter for cocoa butter, but the taste is different. Shea butter has found a market in Europe and Asia as a baking fat, margarine and other fatty spreads, confectionery and chocolate sector due to its high nutritional value (Akhter *et al*., 2018). Shea butter could be a creamy solid at room temperature, easily spreading on bread like dairy butter. It is extremely high in vitamins A and E, and it offers the skin with all of the necessary nutrients for balance and flexibility. Spices such as ginger, garlic, and fragrance leaves are widely used in Nigeria. They are a collection of esoteric food additives that have been used to improve the sensory quality of foods for thousands of years. These spice ingredients provide dishes a distinct flavor, aroma, or piquancy, as well as color (Ifesan, 2020). Several studies have shown that plant extracts or essential oils can be used as food additives and have antioxidant qualities (Banon *et al*., 2007; Capenter *et al*., 2007; Ifesan *et al*., 2009; Ifesan, 2020).

A local factory in Ilorin, Kwara State, provided processed shea butter. Suya spice was obtained in Wuse, Abuja, Nigeria, while ginger, garlic, and fragrance leaf were purchased at a local market in Akure, Ondo State. Sorted ginger, garlic, and fragrance leaves were rinsed in water. They were dried in an air oven at temperatures ranging from 50 to 550 degrees Celsius (°C). The spices were processed into powder form after drying. Shea butter and spice blends were made in two ratios: 70:30 (shea butter: spice) and 85:15 (shea butter: spice) (shea butter: spice). Shea butter and spice were weighed into a blender and properly combined to achieve a homogeneous product, which was then packaged in a transparent rubber plastic and stored at room temperature for 4 weeks. The following labels were applied to the samples: SGG (70:30) SGG Shea butter + Ginger (85:15) SSS Shea butter + Ginger (70:30) - Suya spice + shea butter, SSS (85:15) -SGL, Shea butter + Suya spice (70:30) -SGL Shea butter + Garlic (85:15) SSL -Shea butter + garlic (70:30) -. The saponification value in shea butter-spice samples was reduced when the quality of the butter was improved by adding different spices to make bread spread. The addition of spices to shea butter improved the blends' ability to scavenge free radicals, potentially extending the shelf life of the items. In addition, sensory scores suggested that the shea butter + suya spice blend was the most preferred in terms of taste and color.

Peanut Butter Spread:

The peanut (*Arachis hypogaea*) is officially a pea and belongs to the bean/legume family (Fabaceae). Despite being a legume, it is usually classified as an oilseed due to its high oil content. Peanuts are a good source of protein, oil, and fibre (Lukaniuk *et al*., 2011). Sometimes known as "groundnuts" in some world areas, Peanuts are the edible seeds of a legume. India is the world's second-largest producer of peanuts, with an annual production of 7.131 million metric tons. Peanuts are used to make peanut butter, confections, roasted peanuts, snack items, extenders in meat product formulations, soups, and desserts, in addition to oil. Peanuts are eaten in several ways worldwide, most of which are traditional dishes.

People on excursions to places like Antarctica, space, and hiking use peanuts as their sole source of nutrition. In recent years, it has notably been the source of eradicating malnutrition among the populace of several African countries (Guimon and Guimon, 2012). According to a recent study, cooking peanuts increases their antioxidant content. Boiling peanuts increases the amount of the isoflavone antioxidants biochanin A and genistein by two and four times, respectively (Craft *et al*. 2010). Peanuts and peanut butter are popular as a snack, meal items, and ingredients in various commercial products, and their consumption is linked to a lower incidence of cardiovascular disease, and they offer little harm to positive energy balance. However, concerns have been raised about whether product shape (e.g., whole nut vs butter) and processing characteristics (e.g., roasting and flavouring) may impair their beneficial health benefits. The effects of peanut shape and processing on two cardiovascular disease risk factors: fasting plasma lipids and body weight, were studied in this study. One hundred and eighteen persons (47 men and 71 females; age 292 (SD 84) years; BMI 300 (SD 45) kg/m2) were studied. For four weeks, participants from Brazil, Ghana, and the United States were randomly assigned to eat 56 g of raw unsalted (n 23), roasted unsalted (n 24), roasted salted (n 23), or honey-roasted (n 24) peanuts, or peanut butter (n 24). Peanut shape and processing did not affect body weight or fasting plasma lipid responses in the whole sample. However, when comparing high fasting plasma lipids candidates to those with normal fasting plasma lipids, HDL-cholesterol rose considerably at the group level, while total cholesterol, LDL cholesterol, and TAG concentrations fell significantly. These findings show that the processing characteristics investigated in this study do not impair the lipid-lowering benefits of peanuts or have a detrimental influence on body weight. In order to evaluate the

impact of peanut shape and processing on additional health risk factors, more research is needed (Kiernan *et al*., 2010).

Jackfruit Seed Bread Spread:

The largest tree-borne tropical fruit globally, the jackfruit (*Artocarpus heterophyllus* Lam), belongs to the Moraceae family. It is a monoecious evergreen tree that's thought to be native to the Western Ghats rain forests in India's southwest (Baliga *et al*., 2011). Jackfruit is the national fruit of Bangladesh and Indonesia (Matin, 2015). The name jackfruit is taken from the Portuguese word jaca, which originates from the Malayalam word chakka. Jackfruit is a significant underutilised tropical fruit, frequently referred to as the poor man's fruit that has been used to add value to dishes in India since ancient times (Arora and Parley 2016). This section of the jackfruit is a good source of vital food components like carbohydrates, protein, and minerals (Ocloo *et al*., 2010). However, they are not used to their full potential due to the lack of knowledge about the seeds' nutritional and food production potential.

Jackfruit seeds are valuable by-products that account for more than 15% of the total weight of the fruit (Akter and Huque 2018). As a result, the goal of this study was to explore if the jackfruit seed could be used to make a bread spread that was healthy, inexpensive, and acceptable in terms of consistency, texture, scent, and flavour. Clean jackfruit seeds were cooked for 30 minutes before being blended with jackfruit rags, raw sugar, olive oil, lemon juice, lemon rind, turmeric powder, and salt until a paste-like consistency and smooth texture were reached. In order to eliminate the excess moisture, enhance shelf life, and achieve a spreadable consistency, the mixed ingredients were simmered for 15 minutes on low heat. The finished product was sealed in sterilised jars. The qualities of jackfruit seed spread include a canary yellow hue, a silky texture, a lemony scent, and a sweet acidulous flavour. Potassium (59mg), phosphorus (8mg), calcium (26mg), magnesium (4mg), thiamin (0.02mg), riboflavin (0.02mg), niacin (0.2mg), and vitamin C are all included in one meal (21g) (2mg). On a nine-point hedonic scale, 30 evaluators of both genders assessed the product as very highly liked. The jackfruit seed spread is inexpensive, with a jar of 200g net weight retailing for 58.00. In the refrigerator, the shelf life is 30 days. It was suggested that more research be done on manufacturing jackfruit seed dispersed on a big scale in areas where the fruit is commonly grown (Supit *et al*., 2018).

Cashew Nut Chocolate-Bread Spread:

Consumers nowadays seek products with more tremendous health advantages, which has resulted in significant growth in consumer knowledge and interest in the health-enhancing properties of certain foods or dietary components (Jnawali *et al*., 2016). Many families use margarine as a spread, although it is discouraged owing to concerns voiced by health providers about the trans-fats in margarine. On the other hand, cashew nuts are high in macro-and micronutrients, phytochemicals, tocopherols, and phenolic compounds. Furthermore, the nutritional profile of nuts revealed that they are high in unsaturated fatty acids, fibre, minerals, and proteins, making them healthful meals (Chen *et al*., 2006). They include essential fatty acids, which are required for the body's healthy functioning and play a vital role in controlling various metabolic, transport, and excretion activities (Soares *et al*., 2013). The creation of a nut spread can expand the culinary applications of cashew nuts & introduce customers to a healthier breakfast or snack option (Shakerardekani and Karim, 2012). As obesity, diabetes, and other lifestyle-related disorders threaten the world, health concerns take precedence in people's eating choices. As a result, manufacturing a plant-based spread will provide individuals with a healthier spread option ((Kulkurani and Soni, 2014). A spread is a type of food applied over bread, crackers,

or other pastries. Cheese, butter/margarine, jam/jellies, and chocolate spread are frequently prepared from fruits, nuts, milk, fat, and chocolate. Nut spreads are spreadable nuts mashed into a paste (Shakerardekani, Karim, Ghazali, & Chin, 2013). The preparation method is that all other additional components (sugar, milk, vegetable oil, and flavour) were acquired at the Madina market in Accra, Ghana, and roasted cashew nuts from CRIG's (Cocoa Research Institute) Ghana, Tafo) substation in Koforidua. The roasted cashew nuts were ground into a slurry in a household blender. Cashew nut slurry (CNS) was substituted for cocoa powder (CP) in the preparation of chocolate spread at a rate of 95 per cent, 90 per cent, 85 per cent, 80 per cent, and 75 per cent, for a total of five samples. Thirty-five per cent cashew nut–CP composite, 29.4 per cent sugar, 20 per cent milk, 15 per cent vegetable oil, 0.1 per cent vanilla, and 0.5 per cent lecithin were found in the prepared spreads. A melanger was used to weigh and grind the components. A market-purchased chocolate spread was utilised as a control (Olaleye *et al*., 2021). From the microbial findings, microorganisms such as bacteria, mould, and yeast proliferate with high water activity, but because most confectionery goods have a low water activity (less than 0.75), they are resistant to microbial deterioration and could be considered ambient-stable (Subramaniam, 2010). The mineral content of the cashew nut–chocolate spreads was more significant than the control sample (Mg, Na, and K) as reported by Olaleye *et al*. (2021).

Roselle (*Hibiscus sabdariffa* L.)

Roselle (*Hibiscus sabdariffa* L.) is native of Asia. It is grown commonly in India and Malaysia, and very probably was brought from there to Africa. Roselle has been widely distributed in the tropics and subtropics of both north and south hemispheres as well as in many areas of Jamaica, Trinidad and Tobago, and Central America (Morton, 2014). The Roselle plant is an annual or biannual semi-ligneous shrubby that belongs to the Malvaceae family that can reach between one and three meters of height. Its red-dark stems are abundant and highly branched; the alternated leaves have irregular serrated edges (Ortiz-Marquéz, 2018). The genus Hibiscus, of the Malvaceae family, has over 500 species worldwide. There are two types of *H. sabdariffa* of economic importance. One is *H. sabdariffa* var. altissima Wester, used for fiber production in India, Nigeria, and in some parts of the tropical America. The stems of this variety might be green or red and the leaves are green, sometimes with red veins. Its flowers are yellow with red or green calyces, not fleshy, fibrous, and thorny, therefore, they are not used as food. This type of flower is occasionally confused with kenaf (*H. cannabinus* L.), a source of fiber, similar to *H. sabdariffa*, but more widely exploited (Morton, 2014). The other type is *H. sabdariffa* var. sabdariffa which includes short and thick bushes; different subspecies have been described: bhagalpuriensis, intermedius, albus and rubber. The first one has non-edible red-veined green calyces, the second and third ones have edible greenish-yellow calyces and are also used for fiber production. The last one is an annual, erect, thick shrub of about 2.5 m in height with smooth stems, typically cylindrical and red. Its green with reddish veined leaves are alternated, from 7.6 to 12.7 cm long, and have long or short petioles. Calyces, stems and leaves have acid properties very similar to the cranberry taste (Morton, 2014). In Mexico, the main varieties grown are Creole (cv. long red), Chinese, Jerzy, and Sudan (Domínguez-Domínguez *et al*., 2017).

Roselle as Functional Food

Generally, roselle is considered as traditional medicine for the remedy of diuretic, mild laxative, cancer, cardiac and nerve diseases. Every fraction of roselle plants including leaves, fruits, roots, seeds are utilized in various foods. Among them, red fleshy calyces are employed for making fresh beverage tastes like Ribena, juice, jam, jelly, syrup, gelatin, pudding, wine, cakes, ice-cream and flavors and also dried and brewed into tea (Rao, 2016; Tsai *et al*., 2018). The bright red color

coupled with exceptional flavor and other organoleptic attributes make them valuable food products (El-dawy and Khalil, 2014) such as wine, syrup, ice cream, pies, snakes, tarts and other desserts (Eslaminejad and Zakaria, 2011; Duke and Atchley, 2014).

The drink contains vitamin C and anthocyanins which act as an antioxidant. Anthocyanins present in roselle are dephinidin γsambubioside, cyanidin γ-sambubioside, delphinidin γglucoside and cyanidin γ-glucoside (Mgaya Kilima *et al*. 2014). Due to its commercial potential as a natural food and coloring agent roselle has drawn interest of manufacturers of food, beverage and pharmaceutical (Eslaminejad and Zakaria, 2011). Roselle seeds are used to produce biodiesel and also used as animal feed as the seeds contain 17.8 to 21% nonedible oil (Ahmed, 2010) and 20% protein (Ahmed and Nour, 2011).

Nutritional Value of Roselle

Roselle contains high amount of vitamin C and anthocyanins which makes it unique for nutritional characteristics. Nutritionists have reported that roselle calyces are high in Ca, K, Mg, Na, niacin, riboflavin and iron. Nutritional composition of 100 g fresh roselle calyces, leaves and seeds are shown in Table 1.

Table 1: Nutritional composition of 100 g fresh roselle calyces, leaves and seeds

Constituents	Fresh Calyces	Fresh Leaves	Seeds
Moisture	9.20 g	85.60 g	8.2 g
Protein	1.15 g	3.30 g	19.6 g
Fat	2.61 g	0.30 g	16.0 g
Fiber	12.00 g	10.00 g	11.0 g
Energy	44 kcal	43 kcal	411 kcal
Ash	6.90 g	1.00 g	7.00 g
Calcium	12.63 mg	213.00 mg	356 mg
Phosphorus	273.20 mg	93.00 mg	462 mg
Iron	8.98 mg	4.80 mg	4.2 mg
Carotene	0.03 mg	4135 µg	-
Thiamine	0.12 mg	0.2 mg	0.1 mg
Riboflavin	0.28 mg	0.45 mg	0.15 mg
Niacin	3.77 mg	1.2 mg	1.4 mg
Ascorbic Acid	6.70 mg	54 mg	Trace
Carbohydrates	10.00 g	9.20 g	51.3 g

Source: Islam *et al*. (2016)

MATERIALS AND METHODS

Materials Procurement

The fresh and dried roselle, sugar and salt for the production and formulation of jam were purchased from fruit market in Makurdi and were taken to the Department of Food Science and Technology, Joseph Sarwuan Tarka University, Makurdi for further processing.

Sample Preparation

The modified methods of Ghodke and Mane (2017) was used for the production of fresh and dried roselle jam. Freshly harvested roselle were washed with plenty of water. These were crushed using water through grinder to obtain pulp. Then, sugar was added to pulp and boiling was carried out till the end point was obtained which was judged when product obtained 68.5°Brix TSS. The

finished product was immediately filled into sterilized glass bottle of 500 ml capacity. The product was allowed to cool and bottles were sealed air tight.

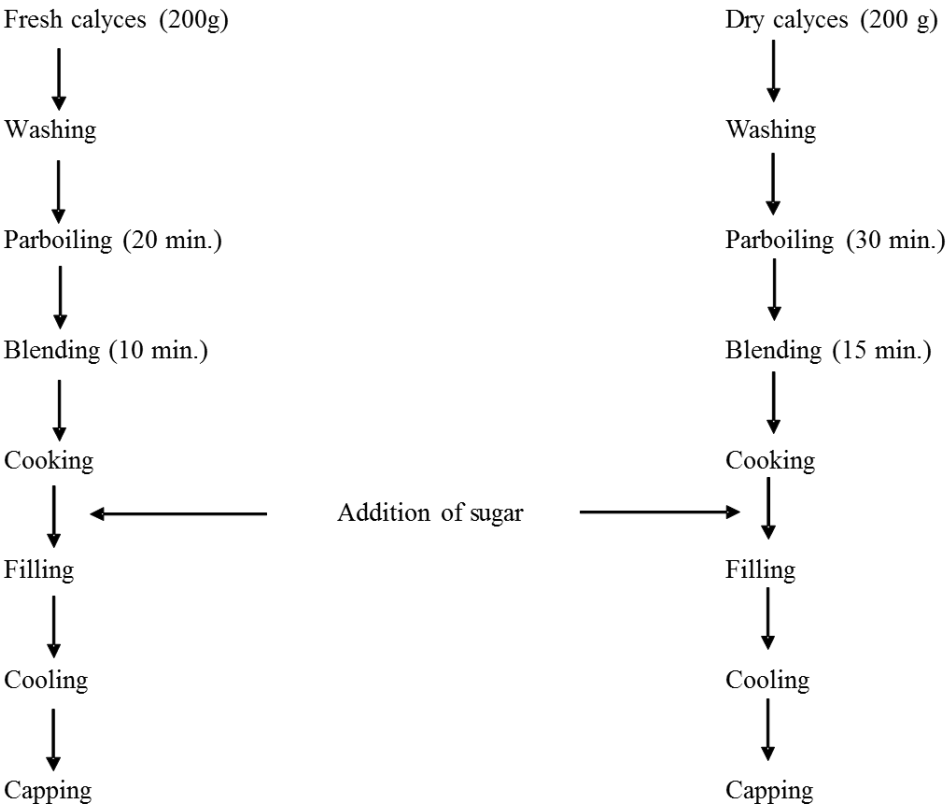

Figure 3: Preparation of Fresh and Dried Roselle Jam

Source: Ashaye and Adeleke (2009)

Physico-chemical Properties of Jam Produce from Fresh and Dried Roselle Calyces

Determination of Vitamins C (ascorbic acid) of Fresh and Dried Roselle Calyces:

Vitamins C (ascorbic acid) was determined using the AOAC method with slight modifications (2012). Approximately 10 g of each sample was weighed into a 250 mL flask, followed by 50 mL of acetone. The mix was left for 2 h with occasional shaking and then filtered. The filtrate was measured, and an equal volume of saturated NaCl was added to wash the filtrate. The resulting mixture was shaken and transferred into a separating funnel to remove the layer of the extract. The supernatant was washed again with an equal volume of 100% potassium trioxocarbonate (IV) (K_2 CO_3), which was separated and washed with 10–20 mL of distilled water. After separating water carotene and extracting carotenoid, the absorbance was defined by a spectrophotometer at 326 nm wavelength using 50:50 acetones and low boiling petroleum ether solution as the blank.

Determination of pH of Fresh and Dried Roselle Calyces:

The pH was determined using the AOAC method with slight modifications (2012). It required the use of a pH meter, calibrated using standard buffer solutions. The electrode was rinsed with distilled water and then dipped into 5 g of the sample, which was dissolved in 50 mL of water.

Determination of Total Titratable Acidity of Fresh and Dried Roselle Calyces:

The total titratable acid was determined using the AOAC (2012) method with slight modifications. Ten grams of the sample was dissolved in 100 mL of distilled water. Thereafter, 10 mL of the

supernatant was titrated with 0.1N NaOH and phenolphthalein as an indicator. The total titratable acidity (%) was defined based on citric acid according to the equation below:
Citric acid = volume of NaOH used × 0.1N × × mL equivalent of citric acid × 100

Determination of moisture Content of Fresh and Dried Roselle Calyces:
The moisture content was determined by hot air oven method as described by AOAC (2012). Empty crucible was weighed and 2g of the sample was transferred into the crucible. This was taken into the hot air oven and dried for 24 hours at 100°C. The loss in weight was regarded as moisture content and expressed as:

$$\%\ Moisture = \frac{W2 - W1}{W}\ X\ 100$$

Where:
W_2=Weight of the crucible and dry sample;
W_1=Weight of empty crucible
W=Weight of the sample

Determination of Ash Content of Fresh and Dried Roselle Calyces:
The ash content was determined by the method described by AOAC (2012). Two (2) grams of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content were then heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\%\ Ash = \frac{(W3 - W1)}{(W2 - W1)}\ x\ 10$$

Where: W1 = Weight of empty crucible, W_2 = Weight of crucible + sample before ashing,
W_3 = Weight of crucible + content after ashing.

Sensory Evaluation of Jam Formulated from Fresh and Dried Roselle Calyces
The jam samples formulated were subjected to sensory evaluation for the attributes of colour, flavour, taste, texture and overall acceptability. A semi-trained fifteen-member panel were used comprising of under graduate students, and scores were allocated by the panelists based on a 9-point Hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). The data collected were subjected to statistical analysis to determine possible differences among samples.

Statistical Analysis
The data generated was subjected to T-test statistics and significance difference was tested at 5 % level of probability.

RESULTS AND DISCUSSION

Physico-chemical Properties of Jam Produced from Fresh and Dried Roselle Calyces
The result of the physiochemical properties of jam produced from fresh and dried roselle calyces is shown in Table 3. The ash contents were between 0.77 % and 0.71%, moisture content (32.71%

and 29.26%), TTA (1.73% and 1.82%), pH (2.87% and 3.67%), and Vitamin C content (27. 79% and 14.49%) for sample A and B respectively.

Sample A had the highest ash content of 0.77% while sample B had the least ash content of 0.71% respectively. All the results do not differ ($p>0.05$) significantly. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after water and organic matter have been removed by heating in the presence of an oxidizing agent (Sani *et al.*, 2008; Ukegbu and Anyika, 2012). Hence, the sample with high percentage ash content as noticed in the study is expected to have high concentrations of various mineral elements. Lower ash contents observed in this study may be due to increased activities of microorganism utilizing the minerals for growth (Ashaye *et al*., 2006).

The moisture content of the jams is presented in Table 3. Sample A recorded moisture content of 32.71% while sample B had moisture content of 29.26% and were not significantly ($p>0.05$) different from one another. The high moisture content of the samples could be attributed to the greater water holding capacity of the jams. This is similar to the findings reported by Babatunde and Bello (2016) in their study on the comparative assessment of some physicochemical properties of roselle jams sold within Kaduna Metropolis, Nigeria.

The results of the TTA value of jam produced from fresh and dried roselle calyces showed no significant ($p>0.05$) differences. Sample B had the highest value of 1.82 g/ml while sample A had lowest TTA value of 1.73 g/ml. The ranged of TTA obtained in this study is similar to report by Ashaye and Adeleke (2009); Ghodke and Mane (2017). The higher TTA value reported for sample B may be due to the presence of acidophiles in the jam sample (Ashaye and Adeleke, 2009).

The pH value for jam produced from fresh and dried roselle calyces differed ($p>0.05$) significantly. The pH value obtained for fresh calyces was higher compared to jam produced from dried calyces. The observed pH values for jams from both fresh and dried roselle calyces were however but lower compared to 5.20 that was reported by Abu (2012). The pH in the present study was slightly lower than that of jackfruit (Eke-Ejiofor and Owuno, 2013) and pineapple jam (Hanan *et al*., 2012) which ranged from 4.8 to 6.3 in low calorie baladi rose petals jam. The pH of jam is an important factor to obtain optimum gel condition.

Vitamin C (ascorbic acid) is one of the major nutrients that are obtained mainly from fruits and fruits products. Apart from the sweet sensation and flavour, the nutritional point of view of fruits and fruits products should also be of importance to consumers. The vitamin C content ranged from 14.49 mg/100 g to 27.79 mg/100 g, there were significant ($P<0.05$) differences across the samples in which the highest vitamin C content was noticed in jam produced from fresh roselle calyces (27.79 mg/100 g). This is an indication that fresh roselle caylces is richer in ascorbic acid compare to dried calyces. However, the result obtained was higher compared to what was reported (27.06 mg/100 g) by Ajenifujah-Solebo and Aina (2011).

Vitamin C are some of the major non-enzymatic antioxidants in the body that produce health beneficial effects by scavenging free radicals (Xu *et al*., 2008). The application of prolonged heat treatments on fruits, such as in the case of jams, can lead to important losses of the beneficial properties of these fruits (Igual *et al*., 2011). Vitamin C functions as a water-soluble antioxidant, and it is also an effective antioxidant that readily scavenges reactive oxygen species (ROS) and reactive nitrogen species (RNS).

Table 3: Physicochemical Properties of Jam Produce from Fresh and Dried Roselle Calyces

SAMPLE	A	B	P-value
Ash	0.77±0.02	0.71±0.02	0.59
Moisture	32.71±1.87	29.26±0.74	0.20
TTA	1.73±0.21	1.82±0.06	0.22
pH	3.67±0. 01	2.87±0.06	0.02
Vitamin C	27.79±1.46	14.49±0.47	0.03

Values are means ± standard deviations of duplicate determinations. Means in same row with p-value less than 0.05 are significantly different. Key: A = Jam produced from fresh roselle calyces, B = Jam produced from dried roselle calyces

Sensory Properties of Jam Produced from Fresh and Dried Roselle Calyces

Data on the sensory properties of jam produce from fresh and dried roselle calyces are presented in Table 4. The sensory score for the appearance of the jam samples ranged from 7.93 to 8.47 with sample A as least preferred and sample B as most preferred with no significant (P<0.05) difference as shown in Table 4. Aroma and taste of the jam samples ranged from 7.53 to 7.73 and 7.07 to 7.73. Mouthfeel of the jam samples ranged from 7.73 to 7.80 for samples A and B respectively. Overall acceptability of the jam samples ranged from 7.60 to 8.07 and sample B was rated most preferred while sample A was least preferred. The recorded sensory scores are an indication that both fresh and dried roselle calyces jam samples were highly acceptable by the consumers. Also, the fact that their overall acceptability is beyond 5.50 on a 9-point hedonic scales revealed that they were equally acceptable by the panelists. The high sensory values of these jams could be due to the color, flavor, and texture of these fruits which is transferred to the final products on processing. Ghodke and mane (2017) also reported the same trend for fresh calyces and guava jam blends in which fresh calyces jam recorded the best overall sensory acceptability due to the arrays of color and taste which this fruit supplies. Othman (2011) stated that fresh roselle calyces are an excellent source of vitamins and minerals and supply a range of sensory characteristics which enhances their eating attractiveness.

Table 4: Sensory Properties of Jam Produce from Fresh and Dried Roselle Calycess

SAMPLE	A	B	P-value
Appearance	7.93±0.88	8.47±0.83	0.10
Aroma	7.53±0.74	7.73±0.70	0.45
Taste	7.07±0.88	7.73±0.70	0.03
Mouthfeel	7.73±1.10	7.80±0.86	0.08
Overall acceptability	7.60±0.83	8.07±059	0.86

Values are means ± standard deviations of duplicate determinations. Means in same row with p-value greater than 0.05 are not significantly different. Key: A = Jam produced from fresh roselle calyces, B = Jam produced from dried roselle calyces

CONCLUSION AND RECOMMENDATIONS

Conclusions

1. Quality of jam produced from fresh and dried roselle calyces were evaluated. The result of the physicochemical properties of jams produced from fresh and dried roselle calyces indicated no significant (P>0.05) differences in ash, moisture and TTA except for Vitamin C where significant (P<0.05) difference was observed.
2. The result of the sensory attributes of jam produced from fresh and dried roselle calyces showed no significant (P>0.05) differences in their level of preferences and acceptability.

3. It was therefore deduced that Roselle jams prepared from either fresh or dried calyces are acceptable for consumption.

Recommendations

Based on the findings of this study, the following recommendations were made

1. that either fresh or dried roselle calyces can be used in the production jam due to their nutritional values.
2. it is however advised that roselle jam be processed from the fresh calyx so as to reduce the rate of Vitamin C loss.

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Extent of Awareness and Utilization of Google Classroom in Teaching and Learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Nigeria

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Abstract:
The study investigated the awareness and utilization of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria. Four research objectives with a corresponding four research questions guided the study. A descriptive survey research design was used. The population of the study comprised of total number of 337 undergraduate students and a total of 18 lecturers in the Department of Agricultural Education of Joseph Sarwuan Tarka University, Makurdi. All members of the population (355) were used as samples for the study as they were all accessible and manageable. A structured questionnaire was used as an instrument for the study. The instrument was found valid for collecting data by an expert in the department. Data collected from the study were subjected to statistical analysis through the use of mean and standard deviation. The findings revealed that to a very high extent, the students and lecturers are not aware of and also do not utilize Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. However, the study indicated that despite the importance of Google Classroom in the teaching and learning of Agricultural Education, the effective use of Google Classroom is faced with several factors. Also, possible ways of enhancing the use of google classroom in teaching and learning of Agricultural Education at Joseph Sarwuan Tarka University, Makurdi, Benue State were proffered. It was however recommended that universities should encourage their lecturers to start using Google Classroom as a medium of teaching their students and that universities should organize a seminar and workshops for their lecturers to train them on the use of Google Classroom as a medium of teaching.

INTRODUCTION

Background of the Study

The integration of technology is not a necessarily new trend in the field of education. For decades, schools around the world have attempted to implement technology plans which aim to supply more frequent use of technology to their students. The assumption is that, technology cannot only improve day-to-day classroom instructions but also, its interactive nature and necessity for life after school have lasting effects on students (Iftakhar, 2016; Keppler, Weiler & Maas, 2014). Many schools began with simple computer labs stationed within the school building for periodic use scheduled by the teachers (Bebell & Kay, 2010; Sell, Cornelius-White, Chang, McLean, & Roworth, 2012).Then, as the personal computing trend continued to grow and as an effort to stay abreast of the 21st century skills, schools began purchasing more computers and other

technology devices with the goal of having much more available devices for student usage (Bebell & Kay, 2010; Bebell & O'Dwyer, 2010; Keppler et al., 2014).

In recent years, there have been drastic changes in the classroom that affected the delivery of instruction and how students are being taught, their classroom experience and how they learn. For instance, most American educators have made the switch from writing with chalk on a chalkboard to writing with dry-erase marker on a dry-erase board or by writing using a touch screen on a Smart Board.

Globally, many school districts introduced a one-to-one technology initiative such that all students have access to a device such as a chrome book, laptop, iPad, etc. Some educators have gone fully digital and paperless, moving toward a greener classroom as well as preparing students for the technological advances of the future. Conversely, some educators have technology-free classrooms and all student assignments are carried out on paper. Most educators at this point use a balance between technology use and paper use when it comes to the medium in which they educate their students. Recently, Learning Management Systems (LMS) such as Blackboard, Canvas, Google Classroom, and Moodle have become increasingly popular at middle school, high school, and higher education levels.

Digital tools stress learners continuing learning activities through technology devices such as desktop computers, notebooks, tablets, and smartphones (Keane, 2012). These devices allow learning to take place without teachers and students meeting face-to-face. Google Classroom is a free application designed to assist students and teachers in connecting, working together, organize and creating assignments. It enables learning to be paperless. As a Digital Tool, Google Classroom is accessible only to users with Google Apps for Education (GAFE). This is a free collaborative set of tools. These tools include web tools like Google Docs, Google Drive, Gmail, etc. All users with GAFE accounts, have access to these web tools (Keppler et al., 2014). Google Classroom can be used at any level of education (basic, post-basic and tertiary), but this depends on the teachers' and students' competence (Bell, 2015). Teachers work together with their students without meeting face to face. Teachers can post materials for their students through this medium, they can also make announcements and create assignments and quizzes for students to complete, submit, and save online either in a web browser or on Google Classroom App.

It also has some benefits such as being paperless, which can be accessed anywhere and everywhere as long as there is an internet connection and from any devices to communicate between teachers and students, to give feedback to students, and personalized learning. It has a learning feature that makes teachers create and handle assignments actively and also provide feedback to students. Google Classroom can be a tool that makes learners become active participants. Google Classroom makes it easier for teachers to handle students' work. It is beneficial for both teachers and students because it is easy and simple to use (Nagele, 2017).

Lots of activities can be done with Google Classroom when the class is ongoing. The activities include; firstly, making announcements: The teacher can give announcements about the update of the class in this section. They can attach files and class materials as well. Secondly, for creating assignments: this is the most substantial feature in Google Classroom. Teachers can upload assignments for students within due time to submit. Students also can download materials that have been uploaded by the teacher to enable them to finish up their assignments. Thirdly, it gives room for the re-use of previous posts: important posts can be re-used by the teacher in this

section, such as announcements, assignment, and questions. And finally, its use in asking questions: in this section, students can create or ask questions to be discussed with the teacher or other students if allowed by the teacher.

Awareness is the state of being conscious of something. More specifically, it is the ability to directly know and perceive, to feel, or to be cognizant of events (Bell, 2015). The development of information and communication technology continues to increase along with the increasing human needs, without exception in the field of education (Husain (2014). Google Classroom can make it easier for teachers to carry out the learning process because it can save time Google Classroom can be accessed anywhere and anytime using an internet network connection. Google Classroom can be accessed using a PC or via mobile phones and tablets based on Android and iOS. With this Google Classroom, teachers and students can connect digitally, this can make it easier for teachers to provide materials and assignments to students and vice versa. One of the advantages of Google Classroom is that students can have online discussions with teachers or other students using the application.

Agricultural education is the teaching of agriculture, natural resources, and land management (Mathews, 2021). At higher levels, agricultural education is primarily undertaken to prepare students for employment in the agricultural sector (Phipps, 2018). Classes taught in an agricultural education curriculum may include horticulture, land management, turf grass management, agricultural science, small animal care, machine and shop classes, health and nutrition, livestock management, and biology. The objectives of agricultural education at this level of education can only be attainable through effective instruction by teachers of agricultural science. Effective instruction is therefore the type of quality teaching and learning that brings about the desired results in the learners, for any instruction to be effective, the teacher has to have a good knowledge of the subject content, adopt the right methodology, select and use appropriate instructional strategies and skills or proficiency in delivering the instruction. Effective instruction is a general term that means systematically providing knowledge.

Teaching refers to the process of imparting knowledge and skills by a teacher to a learner. It encompasses the activities of educating or instructing. It is an act or experience that has a formative effect on the mind, character, or physical ability of an individual (Ayeni, 2011). Ambrose and Flanders (2010) defined learning as a change in knowledge, beliefs, behavior, or attitudes. This change requires time, particularly when one is dealing with changes in beliefs, behaviors, and attitudes.

The teaching and learning processes are effective when relevant instructional strategies are adopted. It is against this background that this study was conducted to determine the awareness and utilization of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Statement of the Problem

Google Classroom act as a classroom facilitator but is unable to replace the role of the teacher. The human aspect of teaching is not something that a system such as Google Classroom can replace or rival at this point, however, the system is something that can be used to enhance and supplement the role of the teacher.

In the present education setting, a problem that many educators report is that students often lack awareness and utilization of Google Classroom evidenced by students losing assignments, forgetting to write names on the assignments, missing deadlines, missing work due to absenteeism, and forgetting to turn in work that has been completed. This present study is therefore conducted to ascertain the awareness and utilization of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Purpose of the Study

The main purpose of this study is to investigate the extent of awareness and utilization of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Specifically, the study seeks to;

1. Determine the extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.
2. Find out the extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State
3. Identify perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State
4. Identify the ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Research Questions

The research study will seek to answer the following research questions;

1. What is the extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?
2. What is the extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?
3. What are the perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?
4. What are the ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?

Significance of the Study

The findings of the study would be of immense benefit to all educational stakeholders, particularly lecturers, researchers, students, curriculum planners, government and the public. The findings of this study would be of benefit to the lecturers as it will enlighten them on the awareness of students on the use of Google Classroom. It will be useful to the government and its agencies as the government would provide easy access to social network by students and these could lead to government subsidizing the cost and also making sure internets connection is required before schools can be established. It would also be useful to curriculum planners at it would enable them to carryout thorough assessment on the implementation, effectiveness and impact of Google Classroom in teaching and learning.

The students themselves would also benefit from this study as they will be exposed to the use Google Classroom as a medium of learning. The study would also be useful to researchers as a

source of literature or related literature that adds to the available materials for present and future research study. The beneficiaries of this study would gain easy access to this article through libraries and online publications.

Scope of the Study

The content scope if this study covers the awareness and utilization of google classroom in teaching and learning of Agricultural Education, while the geographical scope is the Department of Agricultural Education, Joseph Sarwuan Tarka University Makurdi, Benue State.

Operational Definitions

LMS*:*

Learning Management System: a software application for the administration, documentation, tracking, reporting and delivery of educational courses or training programs.

Google Classroom*:*

Free web service developed by Google for schools that aim to simplify creating, distributing and grading assignments in a paperless way. The primary purpose is to streamline the process of sharing files between teachers and students.

Technology Integration*:*

The international use of various types of technology in a setting such as schools and Classrooms (Bakia et al., 2009).

Google Chrome Book*:*

A laptop computer that relies on internet access, allowing users to share and run cloud-based applications (google.com, 2016)

GAFE: (Google apps for education):

Google for Education is a service from Google that provides independently customizable versions of several Google products using a domain name provided by the customer.

Smartphone:

A mobile phone that performs many functions of a computer, typically having a touchscreen interface, internet access, and an operating system capable of running downloaded apps.

Canvas*:*

A strong, coarse unbleached cloth made from hemp, flax, or a similar yarn, used to make items such as sails and tents and as a surface for oil painting.

Digital Tools:

are programs, websites or online resources that can make tasks easier to complete. A lot of these can be accessed in web browsers without needing to be downloaded, and you can access them both at home and at work.

LITERATURE REVIEW

The chapter is organized and presented under the following sub-headings; Conceptual Framework, theoretical framework, Empirical Studies, and Summary of Literature Review

Theoretical Framework

Piaget's Constructivism Theory of Knowledge:

Piaget's constructivist theory of knowledge was propounded in 1986. His theory states that humans generate knowledge and meaning from an interaction between their experiences and ideas. Piaget also called such a system of knowledge schemata where knowledge is gained through experiential learning. Piaget maintained that humans (i.e., learners in this context) can construct their information in the process of interacting. Piaget recognized that human beings are born as active exploratory information-processing organisms and actively construct their ways of thinking about things based on their current level of maturation, and actual experiences with objects, people, and ideas. To Piaget true learning/knowledge is not something handed down by the teacher alone, but something that comes from the child through the process of spontaneous invention and discovery.

Therefore, by relating this theory to the present study, one can say if a lecturer teaching Agriculture Education allows the learners or students to make deep and further findings/inquiries through the use of Google Classroom, this would lead to relevant questioning about the lesson taught in class to enhance their level of understanding in the subject. This benefit or achievement of more ideas and experience is constructed by them as a result of their research through the medium of Google Classroom, interaction in class; exchanging of ideas, etc. Piaget theory of constructivism may be a credible explanation for students' academic achievement in Agricultural Education using Google Classroom in teaching. The use of Google Classroom in teaching enables learners or students to gain skills and knowledge by making them think critically for a long period asking relevant questions about what they are ignorant of and responding to complex questions, problems, or challenges as a result of the fascinating nature of Google Classroom. Google Classroom in teaching and learning is based on applying specific knowledge or skills and on improving student involvement and motivation to promote independent thinking, self-confidence and social responsibility. Google classroom in teaching and learning may be more effective in the positive development of the learner's academic achievement. Students taught with google classroom in teaching may be more successful if aware of its importance in teaching and learning as the present researcher seeks to find out.

John Dewey's cognitive Theory:

John Dewey's cognitive theory was propounded 1998. Dewey states that 'knowledge emerges only from situations in which learners have to draw them out of meaningful experience'. Dewey argued that education and learning are social and interactive processes and that the school as a social institution provides an environment in which social reforms can and should take place. He sees the classroom as a social context where students can take part in manipulating materials and thus form a community of learners who construct their knowledge together. Dewey believed in one permanent frame of references; namely the organic connection between education and personal experience. He maintained that every experience enacted modifies further experience and results in a positive attitude and growth of understanding. Another vital issue raised by Dewey is that, he believed that students thrive in an environment where they are allowed to experience and interact with the curriculum, as such Dewey emphasized that all students should have the opportunity to take part in their learning. Dewey encouraged hands-on learning and stated that it is impossible to procure knowledge without the use of objects (Google Classroom) that impress the mind. As a constructivist, Dewey believed that teachers/instructors are partners in the learning process whose guidance and assistance help learners to construct their learning and independently discover meaning within the subject area. The obvious implication of Dewey's

theory to this study is that in the learning process, students must be engaged in meaningful activities that induce them to apply the concepts they are trying to learn. The researcher therefore seeks to ascertain the awareness and utilization of a more relevant and effective teaching and learning approach for higher performance in agricultural education.

Conceptual Frame Work

Teaching and Learning in Agricultural Education:

There are various definitions of teaching as well as many activities that are involved in the teaching and learning process. Nzeribe (2012) defined teaching as 'the conscious and deliberate effort by a mature or experienced person to impart information, knowledge, skills and so on to an immature or less experienced person, with the intention that the latter will learn or come to believe what is taught '. On the other hand, Mandore (2011) explained teaching to mean the various types of principles and methods of educating or instruction that are used to impact the knowledge and skills of students by an instructor. Tharp and Gallimor (2004) defined teaching as assisted performance beyond the zone of proximal development (assisting learners to perform beyond their current capacity). Sequeira (2012) also stated that teaching is a set of events that are designed to support the internal process of learning. Teaching (Instruction) is outside the learner. Learning is internal to learners. You cannot motivate others if you are not self-motivated. Motives are not seen, but Behaviors are seen. Learning is both a motive and behavior but only behavior is seen, learning is internal, and performance is external.

Learning is the process of acquiring new or modifying existing knowledge, behaviors, skills, values, or preferences. Evidence that learning has occurred may be seen in changes in behavior from simple to complex, from moving a finger to skill in synthesizing information, or a change in attitude (Richard, 2006). The ability to learn is possessed by humans, animals, and some machines. Learning may occur consciously or without conscious awareness (Daniel, Costa, Pita, & Costa, 2011). Sequeira (2012) stated that learning is about a change: the change brought about by developing a new skill, understanding a scientific law, and changing an attitude. The change is not merely incidental or natural in the way that our appearance changes as we get older. Learning is a relatively permanent change, usually brought about intentionally.

Teachers are in charge of the teaching-learning relationship, they have the primary responsibility of imparting knowledge. A good teaching should be an academic process by which students are motivated towards their zone of proximal development (Holt and Willard-Holt, 2000). Vigotsky (2010) identified the developmental level of a child by what the child can do alone, while what the child can do with the assistance of another is what is taught. The zone of proximal development awakens and rouses to life the mental capacities of learners of all ages (Tharps, 2004). When learners are motivated towards their zone of proximal development, learning is sustained and when learning is sustained, learners are positively influenced on how to think, act and feel, a process that elevates students to learn remarkably. Teaching is an academic process that involves two groups of people: the teacher/instructor and students/learners and information which include knowledge and like that are transmitted. Due to these activities involved in teaching, the concept of teaching is preferably discussed as teaching and learning. According to Sawa (2005) teaching and learning are considered as two sides of a coin, because teaching is meaningless without learning. Hence, teaching without learning is considered mere talking, for teaching to be meaningful it must be effective in promoting knowledge skills, and values. Given this, a document by Shawnee State University (2001) stated that the accepted criterion for measuring good teaching is the number of learning outcomes demonstrated by the learners and also through the

perspective of learners 'engagement in the teaching and learning process. Shawnee State University (2001) therefore characterized effective teaching as: (a) teaching for understanding in ways that help learners understand ideas and perform proficiently and (b) diversified teaching in ways that would help diverse learners to find productive paths to knowledge and constructively.

Also, Borich (2008) stated that effective teaching and learning should;

1. Be inquiry-based: teachers should build the subject program around the inquiry process by (a) selecting content and adapting curricula to address students' learning needs, interests, and prior knowledge. (b) Developing activities and assessments that promote students' depth of understanding (c) working together as colleagues across disciplines and class levels
2. Facilitate learning: Teachers should guide and facilitate learning with a variety of strategies such as (a) Helping students focus their inquiries and ideas (b) orchestrating student discuss (c) requiring students to share responsibility for their learning (d) modeling curiosity, skepticism and the skills of inquiry.
3. Provide learning environment: Teachers should create and manage learning environments that (a) provide enough time for extended inquiries (b) are safe but flexible and supportive of students' activities and actions (c) feature materials and tools for doing and use of resources outside school.
4. Create classroom community: Teachers should develop communities of learners in which all members (a) respect the ideas and diverse experiences of others (b) collaborate and make decisions about the contents and context of their work (c) adopt the intellectual rigor and attitudes that make learning possible (d) engage in on-going formal and informal discussion.
5. Be ongoing assessment: Teachers should engage in ongoing, assessment of instruction and learning by (a) using multiple methods to determine students' understandings (b) guiding students in self-assessment (c) using assessment information to guide their teaching and improve their practice. From the above assertions an effective pedagogy is that which engages students actively in the teaching and learning process and guides students successfully through exploration to become creative and critical thinkers as well as problem solvers. Effective teaching encourages students to grapple with the ideas that they need to develop their understandings and construct meaningful knowledge. Pedagogy with these inherent qualities includes inquiry methods of teaching among the innovative teaching methods.

Concept of E-Learning:

E-learning is being introduced at the beginning of third millennium. E-learning allows user can access course material everywhere via the internet. Using e-learning can encourage and improve learner's interaction in the class. Based on Agarwal and Pandey (2012), e-learning focuses on the use of technology in learning and education. E-learning refers to the use of information and communication technology in the learning process which consists of electronic media. According to Guri-Rosenblit (2005) "E-learning is the use of electronic media for a variety of learning purposes that range from add-on functions in conventional classrooms to full substitution for the face-to-face meetings by online encounters". Stockley (2017) stated that e-learning implies the use of electronic devices such as computers or mobile phones) in ways to provide educational training or learning purposes. Sangrà, Vlachopoulos & Cabrera (2012) also stated that e-learning can be defined as a natural evolution of distance learning which utilizes the newest tool in the technological context for arrangement in education.

From those definitions, it can be concluded that e-learning is learning that utilizes electronic technologies to access educational curricula outside the traditional classroom and it refers to learning that is delivered online. E-learning makes the learning process easier, such as sharing material or files, submitting tasks, and doing quizzes. E-learning also has been applied in many institutions (e.g., schools and universities). Through e-learning, both teachers and students can easily communicate. Also, the teacher can give feedback on the assignment via an online class platform. A very clear and modern tool for actualizing e-learning is Google Classroom which is used by instructors/lecturers in higher institutions to connect digitally and as well make teaching and learning easier for teachers to provide materials and assignments to students and vice versa.

Google Classroom:

Google Classroom is a tool which facilitates students and teacher collaboration; also, teacher can create and distribute assignments for students in an online classroom for free (Beal, 2017). It makes teachers simply build groups to share assignments and announcements. Google Classroom can be a tool that makes learners become active participants. Nagele (2017) said, teachers can create active lessons which are student-centered, collaborative, and unforgettable just through Google Classroom, because it provides easy-to-use learning features with students of all categories able to cooperate. Google Classroom is helpful to all of learner categories and including adult learners. It also has some benefits such as paperless, can be accessed anywhere and everywhere as long as there is internet connection and from any devices, to communicate between teachers and students, to give feedback to students, and personalized learning. It has a learning feature that makes teachers create and handle assignments actively and also provide feedback to students. Google Classroom makes it easier for teachers to handle students work. It is really beneficial for both teachers and students, because it is easy and simple to use. Several activities can be achieved with Google Classroom among students (Janzen, 2014). First of which can be used to create announcement (Nagele, 2017). With google classroom, teachers can give announcements about the update of the class in this section. The teachers can as well attach files and class materials to be downloaded / viewed by the students. Secondly, it could also be used to create assignment. This is the most substantial feature of Google Classroom. Teacher can upload assignments for student within due time to submit. Student also can download materials that have been uploaded by teacher to finish their task. Thirdly, google classroom is also used to create questions. In this section, student can create question to be discussed with teacher or other students if allowed by teacher. Fourthly, google classroom is used to re-use post. Important post can be used by teacher in this section, such as, announcement, assignments, and questions (Nagele, 2017).

Awareness of Google Classroom:

Google classroom was reported to have been introduced in May, 2014 and subsequently released in August, 2014 as a tool for teachers that functions as an interface layered on top of the Google Application for Education (GAFE) that establishes a collaborative environment for students – teachers' interaction (Brown & Hocutt, 2015). The system encompasses of several tools that when optimized efficiently, the learning environment is observed which leads to proper teaching and learning process. Google Classroom being a universal tool for teaching and learning allows teachers across several disciplines to customize their classroom for effective online collaboration. It is a suit for education that comes along with other associated tools such as Google Drive, Google Docs, Google Sheets, and Slides, sign up through the use of a Gmail account altogether to establish a conducive learning platform called a classroom existing in a virtual space (Madhavi, Mohan, & Nalla, 2018). Since the emergence of this great tool for blended and complete online

teaching, multitude a number of teachers were recorded finding their way to it (Madhavi et al., 2018) just as recorded in a similar study by Iftikhar (2016) who noted that, in Daffodil International University around September 2014, more than 30 teachers were already aware of google classroom and are recorded to have started using Google Classroom. Similar to the statement of Xanthoula (2015) that many organizations have recently embraced live class mode of e-learning to produced up to the task students besides cutting transportation time and cost; likewise associated cost engaged in face-face tutoring.

Educational institute's management or administration has a major role to play in integrating technology in classrooms as they have to finance or manage the process and ultimately decide to what extent they plan to use technology. Öznacar and Dericioğlu (2017) conducted research in high schools on the role of administrators in the use of technology in which they discovered that the administrators held positive beliefs regarding integrating technology in the classroom. One of the many reasons for the failure of not successfully integrating technology was that the administrators believed that 80% of their teachers were not technologically aware to use it effectively; hence, the project failed.

Utilization of Google Classroom:

Google Classroom has copious facilities which are beneficial for its users. A few of them are user friendly, cost free, cell phone friendly, and time saving. Using Google Classroom is really easy. Based on Janzen (2014), "Google Classroom's design purposefully simplifies the instructional interface and options used for delivering and tracking assignments; communication with the entire course or individuals is also simplified through announcements, email, and push notifications". Using Google Classroom does not need any cost. It is free for anyone. Although users have institutional Google Account, they still can use it for free. Anyone can use Google classroom on any mobile device as long as there is internet connection, because it designs to be fast respond. Janzen (2014) also states that "mobile access to learning materials that are attractive and easy to interact with is critical in today's web connected learning environments". By using Google Classroom both teacher and student can save their time. According to Iftakhar (2016), it integrates other Google apps, like, Docs, Slides, Drive and Spreadsheets. Nevertheless, the whole process of administering assignments, grading, formative assessment, and feedback is simplified and streamlined.

In a study by Muslimah (2018), where he applied measurable examination technique to answer four research question which are categorized into four parts; easiness of availability, supposed helpfulness, interaction and communication, learners' gratification. The people used as object to carry the experiment were 190 students in English Language Education Department batch 2014, 2015, 2016, and 2017. The contents of questionnaire were Easiness of accessibility (6 questions), Perceived Usefulness (7 questions), Communication and Interaction (6 questions), and Students' Satisfaction (4 questions). The answers to each item used a 5-points Likert scale. The questionnaire contained 23 items. The raw piece information was examined by using frequency and means. The mean score shows $\bar{X}$ = 3.82. The result indicated that students feel Google Classroom is useful and they were satisfied with Google Classroom as an online learning tool. Also, the study was repeated and carried out with 400 level 2019/2020 session of undergraduate student in Four Departments, University of Port Harcourt. They were taught using the Google classroom to access their level of Perceived ease of use, perceived usefulness towards the use of Google classroom as a learning tool. Descriptive analytic survey research method and proportionate stratified sampling technique for collection of data from 175 students registered.

Questionnaire was distributed during one of their lecture periods in physical classroom. The questions were on a four-point scale using SPSS to analyze the data. The study reported similar outcome of teachers and students' usefulness and acceptance of google classroom as an innovative and motivating learning approach. Several studies were conducted about the students' attitude towards and acceptance of the Learning Management System (LMS) by using the Technology Acceptance Model (TAM) of Davis (1989). The research study of Al-Maroof and Al-Emran (2018) conducted at Al Buraimi University College (BUC) in Oman proved that both the perception of ease of use and usefulness in TAM positively affects the behavioral intention, which in turn affects Google classroom usage. This was supported by the research study of Trayek and Hassan (2013) conducted to both full-time and online learning students at the International Islamic University in Malaysia (IIUM) which proved that perceived ease of use and usefulness towards the use of LMS. A parallel study conducted by Kumar and Bervell (2019) investigated students' attitudes on Google Classroom as a mobile learning platform. The findings revealed significant non-linear relationships between motivation and habit. Students' intentions were positive to accept that Google Classrooms were related to habit, motivation, and performance expectancy. The research study of Munasinghe and Percy (2016) conducted among the students of Rajarata University of Sri Lanka also supported the previous research. The study indicated that perceived usefulness and ease of use have significant effects on the attitude towards the use of LMS. It confirmed that students have positive attitudes toward Google Classroom. It was similar to the research study of Indahyanti and Sukarjadi (2015), revealing that the factors influencing students' acceptance of an LMS at Politeknik SAKTI Surabaya are perceived usefulness, perceived ease of use, and attitudes towards use, affecting the intention to use and significantly affecting the actual use of LMS. Furthermore, in the study of Alshorman & Bawaneh (2018) the students' attitudes towards using learning management systems in Teaching and learning were positive.

Factors Militating Against the Proper Use of Google Classroom:

Despite various benefits of Google Classroom, Google Classroom also has some limitations. Some of them as mentioned by Pappas (2015) are limited integration options, to Google, no automated updates, and difficult learner-sharing and editing problems. It is difficult for teachers to manage teaching materials and to set deadlines for assignments because Google Classroom is not synchronized with Google Calendar or any other calendar. Some of Google Classrooms' buttons are only familiar to Google users. It can make new users feel confused or need more time to deal with it. That is why Pappas defines Google Classroom as too "googlish". There is no auto-update feature in Google Classroom; it makes learners miss an important announcement because they should refresh it regularly. Also, students cannot share their documents with others without permission from the teacher. Learners can only edit assignments after they create and distribute to Google Classroom. They can keep and delete any part of the assignments. Below are identified potential obstacles facing the students and teachers for quality online learning at present;

Quality and Standard of the Learning Process:

More often than not, when there is a typical class involved, class efficiency is easier to calculate. There is a system that protects the consistency of face-to-face transitional courses. The interactions among students will stimulate their motivation to study better. Students will follow the arranged schedule and become more focus during the stipulated time. Teachers can monitor their students closely and give timely feedbacks. On the other hand, class activities can happen at any time of the day in online learning. When everything is at your fingertips, coming back to the classroom or for work becomes meaningless. The rethinking of the so-called standards of practice and quality will be necessary and can require a paradigm shift in our thinking (Setiadi,

2020). In order to make the session efficient, both teachers and students must have coherent interaction on google classroom.

Heavy Dependence on the Internet Connection:
Google Classroom requires high and stable speed of internet connection. It also requires either a computer, smartphone or tablet with minimum specifications to support the running of google classroom smoothly. If a student does not have one of these, he/she will have some problem to learn properly especially when they have to sit for tests or quizzes which are usually timed and cannot be repeated. In a previous study by Safford and Stinton (2016), students' learning and online activities are troubled by the low internet connectivity and speed. Thus, a stable internet connection and also a suitable gadget are critical in realizing the virtual class through google classroom (Ula, Lilis & Syahrizal, 2019).

Difficulty in Self-Regulation:
Due to the generous flexibility of Google Classroom, students depend heavily on their self-regulation; time management, discipline and readiness. Students exert more autonomy power and more often than not, this leads to procrastination (Safford and Stinton, 2016). In the traditional classroom, students' procrastination could be noticed and addressed directly by the teachers. It is different when it comes to google classroom as students have reduced seat time with their teachers. They also could not capture the teacher's physical presence which contributes negatively to their learning process on google classroom. However, this could be overcome by the teachers themselves.

Ways to Enhance the Use of Google Classroom in Teaching and Learning:
In spite of some drawbacks, we can conclude that Google Classroom is a good thing for students and teachers because it is easy to use, efficient, effective, better for the environment, and enable collaboration between teacher and student becomes easier. With Google Classroom, learning process can be effective and efficient because students and teachers can access Google Classroom anytime and anywhere in electronic devices with internet network.

Adequate Funding:
According to Acharu and Solomon (2014), adequate infrastructural (instructional) facilities are evidently linked to adequate funding by Governments. This situation is usually in response to conditionality's imposed by International Financial Institutions (IFIs). Despite the foregoing, Nigeria still remains a major defaulter in complying with the UNESCO recommendations that at least 26% of the National Budget must be committed to education. However, adequate funding of schools will go a long way in improving access to basic facilities required for google classroom utilization.

Good Policy Formulation and Implementation:
A well-articulated educational policy by the Nigerian government will improve utilization of google classroom. If more attention is given to education than other sectors will help the Nigeria education. This is evidence in the provision and appropriate use of instructional facilities especially Agricultural Education teaching and learning materials (Goshit, 2006).

Appropriate Maintenance:
According to Udin and Uwaifo (2005), most equipment and infrastructure in Nigeria are in despair/poor use and decay due to poor maintenance culture. Presence of maintenance culture in

our school systems will enhance utilization of trending technology other than caused major setbacks. Instructional facilities that break down in public secondary schools are sometimes difficult to repair. In such a case damaged equipment continue to depreciate till it finally become dead. Miller and Akume (2009) however noted in their work that all stakeholders in the educational sectors are expected to be partners in the maintenance of school equipment while parents and government are to provide finance for maintenance activities. In the same way, school authorities are to detect fault and utilize fully the available equipment.

Corruption in Education System Should Be Put to Check:
The Nigeria education system has witnessed unprecedented anomalies in terms of fund diversion, bribery and falsification of unverifiable projects to the personal gains of individuals and to the detriment of education in Nigeria. Corruption has crippled the provision of educational materials to a sorry level that some government owned institutions do not have the necessary materials for effective teaching and learning. However, with appropriate avoidance of corruption and knowing to do what is right in our society at large, these abnormalities could be erased. Priye (2016) lamented that corruption began to have its serious and negative effects on education in the middle and late 1980s as the psychosocial beast beclouded the minds of those who ruled Nigeria. According to him, the scrambled to loot as much as possible by those in position of power resulted in the neglect of the educational sector.

Good Students' Attitudes Toward Educational Facilities:
The belief that government property is nobody's property sometimes affects the availability, maintenance and continuity of instructional equipment in our tertiary institutions. The syndrome of "It is government property" has become a canker worm eating deep into the very fabric of our educational system as students mishandle equipment and go scot-free. However, with good and appropriate students and teachers attitudes to these facilities can help enhance the use and effectiveness of google classroom in our schools (Acharu & Solomon, 2014).

Non-Compromise by the Supervisory Body:
Essen (2012) in Robert (2014) reported that the Federal Republic of Nigeria set up the National Board by Decree (Act) No. 9 of 11th January, 1977 as the higher education supervisory parastatal in charge of secondary education to coordinate activities of the subject to ensure that courses offered and methods used reflect national needs, interest and aspirations of the society. This body accredits and reaccredits programmes of study in the secondary school. Many a times the people send to accredit programmes compromise their authority by taking gratification to accredit programmes without adequate facilities. Avoidance of these acts would in a long way improve utilization of appropriate teaching facilities.

Empirical Review
Shaharanee, Jamil, and Rod (2016) conducted research about the effectiveness of Google Classroom's active learning activities for data mining subject under the decision sciences program. Technology Acceptance Model (TAM) has been employed to measure the effectiveness of the learning activities. The target populations for this research were 1050 students who enrolled in data mining subject where the class was taught in a computer lab. In order to have random selection method, simple random sampling had been applied when choosing the sample to randomly select 100 sample sizes. The survey included questions on demographics, five predictor variables, and student satisfaction. Demographic questions covered gender, marital status, course, and the average on internet accessed. In order to develop the questionnaire, the

Internet self-efficacy scale was developed by Eastin and LaRose and used as reference. A total of 100 valid unduplicated responses from students who enrolled in data mining subject were used in this study. The results indicated that the majority of students felt satisfy with Google Classroom's tools that were introduced in the class. Results of data analysis showed that all ratios are above averages. In particular, comparative performance is good in the areas of ease of access, perceived usefulness, communication and interaction, instruction delivery and students' satisfaction towards Google Classroom's active learning activities.

This study relates with the present study as it dealt with the effectiveness of google classroom but however differed with the present study in its geographical and content scope. The present study seeks to go further in ascertaining the awareness and usefulness of this google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University of Agriculture, Makurdi.

Iftakhar (2016) evaluated what and how Google Classroom works. The purpose of this study was to report the overall view of Google Classroom from different class. This research presents brief features of Google Classroom. In addition, some adoption factors (such as organizational, social, personal and technological) have been reassessed for the research purpose. The research questions are: What factors influence teacher to use Google Classroom, how does teacher use Google Classroom in their teaching, what are the barriers to use Google Classroom, what are students' responses to the Google Classroom? The analysis of the results of the questionnaire indicate that this study can be effective in understanding and evaluating teachers' and learners' perceptive to ensure quality teaching and learning through Google classroom. This study also presents some new evidence on the potential of Google classrooms in teaching. This study used interview and observations to collect the data. The participants were teachers and students of Daffodil International University. The interviews were conducted with seven teachers: four males and three females. Three teachers are from BBA Department, one teacher is from LLB, two teachers are from English Department and one from CSE. 35 students also selected from English Department. The total respondents were 42. The result of the study shows that from teachers' perspective, they agree that Google Classroom is very useful. From students' perspective, some said that Google Classroom is also helpful, while others stated that they are scared when using Google Classroom. The third study is from Wijaya (2016). The study is about analysis of factors affecting on the use of Google Classroom to support lecturers. The study was developed by adopting the model of TAM to see from both the perception in the TAM that affect the use of Google Classroom by some students STT Musi. Population of this research is the students who are already using Google Classroom in the lecture. Data obtained as much as 90 questionnaires distributed by using purposive sampling technique to all students active in the odd academic year 2014-2015. Results from this study showed that the perceived ease of use and individual's perception of usefulness positively affect the use of Google Classroom.

While this study has related how google classroom operates and functions in a class setting but has however failed to reveal factors that may contribute to the usefulness of this google classroom. The present study aside providing information on the utilization of google classroom will as well provide vital information regarding factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education and also Identify various ways of enhancing the use of google classroom in teaching and learning of Agricultural Education. Similarly, Rossytawati (2018) investigated the challenges in using Google Classroom. The purpose of the research is to identify the challenges of using Google Classroom as a learning tool for

students of English Language Department Islamic University of Indonesia. The method of the research is quantitative research. The research involved 126 students of English Language Department in Islamic University of Indonesia, consist of 3 batches there are 2014, 2015 and 2016. The result of the research can be interpreted as the students feel that most challenging aspect in using Google Classroom is not very helpful for them to minimize their time and effort in doing and collecting the assignment. The differences between these researches and my research are on the variable, subjects of the study, participants, and methodology used. In this study, the researcher adopts the Shaharanee et al (2016) questionnaire because the questionnaire is reliable with value above 0.90. This research aims to identify students' responses on using Google Classroom. The participants were students of English Language Education Department batch 2014-2017 because students in English Language Education Department already used Google Classroom. This research used quantitative method. Those researches are relevant with this study because those researches also examining about Google Classroom; thus, they can be used as references.

Summary of Literature Review

Over the years use of ineffective teaching approach in teaching Agricultural Education has hampered harnessing of the potentials of students of Agricultural Education. In view of this, researchers have continued to search for an effective teaching approach that could facilitate learning and enhance students' achievement and interest in sciences. The utilization of google classroom in teaching and learning is identified among other innovative teaching approach as one of the trending approaches that have not been determined. Google Classroom is an application that allows the creation of classrooms in cyberspace. In addition, Google Classroom has also become a means of distributing tasks, submitting assignments and even assessing assigned tasks collected. The review is based on constructivism hence the theories by some constructivists like John Dewey and Jean Piaget among others formed the theoretical base for the study. The general views of these cognitive theorists were reviewed all indicating that learners are possessors of their knowledge and construct knowledge through fascinating experience.

The empirical studies were revealed under the following subheadings. Studies on the effectiveness of Google Classroom's active learning activities for data mining subject under the decision sciences program, study on what and how Google Classroom works, study on analysis of factors affecting on the use of Google Classroom to support lecturers and the challenges in using Google Classroom were reviewed. From the review, it has been seen that google classroom improves students' performance and interest in so many subjects. Therefore, there is need to ascertain the awareness and usefulness of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

In view of the above, the researcher intends to investigate the awareness and usefulness of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

METHODOLOGY

This chapter dealt with the methods used to collect data for the study. It was organized into the following sections: research design, Area of the Study, population, sampling procedure and sampling size, research instruments, validation of the instrument, reliability of the instrument, methods of data collection and data analysis techniques.

Research Design

The research design used in this study is a descriptive survey research design. It sought the opinion of students through questionnaire in order to establish the extent of awareness and utilization of Google Classroom in Agricultural education. The reason behind choosing this design was because this study focused on measuring the opinion of students and teachers towards their extent of awareness and utilization of Google Classroom in teaching Agricultural Education.

Area of the Study

The study was conducted in Joseph Sarwuan Tarka University, Makurdi. Joseph Sarwuan Tarka University, formerly known as the University of Agriculture, Makurdi (UAM) is a higher education institution in Makurdi, Benue State, Nigeria (Nexus Strategic Partnerships, 2007). The university was established in 1988, following the recommendations of a 1987 federal government White Paper on Higher Education curriculum and development in Nigeria (Anyanwu, 2011). It succeeded the Makurdi Campus of the University of Jos (Established in 1984), which in turn had succeeded the former University of Technology, Makurdi (established in 1980). The University was set up to pioneer new institutional approaches to the generation and dissemination of new agricultural technologies. The vice-chancellor is Professor Anande Richard Kimbir, and the chancellor is the Emir of Ilorin, Alhaji Ibrahim Sulu Gambari CFR (Editor, 2019). On 14 July 2019, President Muhammadu Buhari approved a bill renaming it the Joseph Sarwuan Tarka University (Premium Times, 2019). The university is sited on the bank of River Benue, and located about 300km South of the Federal Capital, Abuja and 800km North of the commercial city of Lagos; Joseph Sarwuan Tarka University, Makurdi occupies an arable land area of 8,048 hectares thus making it the largest holder of agricultural land mass amongst institutions of its kind.

Population of the Study

The research population for this study was 355, drawn from the Department of Agricultural Education, Joseph Sarwuan Tarka University, Makurdi. The target population consisted of 337 undergraduate students (Examination Officer, Department of Agricultural Education, 2023) and 18 lecturers in the Department of Agricultural Education of Joseph Sarwuan Tarka University, Makurdi.

Sample and Sampling Techniques

All members of the population were used as they were all accessible and manageable. Therefore, the entire 337 students and 18 lecturers of the Agricultural Education Department were used for the study.

Instrument of Data Collection

The questionnaire was used as an instrument for the study. The questionnaire was used because they are considered economical and easy to formulate and analyze. In addition, the questionnaire elicits a lot of data and gives a greater depth of response. The questionnaire will be sectioned into two (part A, made up of the bio-data section, and Part B- made up of 4 sections) and have both closed and open-ended items. The scale will be rated as strongly agree = 4, agree = 3, disagree = 2, strongly disagree = 1 respectively. The instrument will be used to collect data from undergraduate students and lecturers in the Agricultural Education Department using the constructed Awareness and Usefulness of Google Classroom in Teaching and Learning of Agricultural Education Questionnaire (AUGCTLAEQ). A mean benchmark of 2.50 will be established in deciding on the criteria for answering the research questions.

Validation of Instrument

The research instrument was face-validated by an expert from the Department of Agricultural Education. The validates, corrections, and suggestions were used in the final draft of the instrument. The instrument items were validated in terms of clarity of language, appropriateness, and adequacy of the items in measuring what they were supposed to measure.

Reliability of the Study

The researcher carried out a pre-test of the questionnaire by issuing a set of questionnaires to 20 selected undergraduate students from Benue State University (BSU) which are outside the original respondents chosen for the study. The reliability of the instrument was estimated using the Cronbach's Alpha method. The reliability coefficient of the instrument was 0.95. The instrument was deemed reliable as the coefficient was above the 0.70.

Method of Data Collection

The researcher administered the instruments to the respondents with the help of two research assistants. Out of the 355 copies of the instrument distributed, 344 copies representing 96% were retrieved and analyzed while 11 copies were lost.

Analysis of Data

Data from the questionnaires were analyzed using mean and Standard Deviation to answer the research question for research questions 3 and 4. A Mean bench mark of 2.5 was established using the mean method formula.

$$\frac{4+3+2+1}{4} = 2.5$$

Generally, any item with a mean value of 2.50 or above was regarded as being acceptable while any item with mean value less than 2.50 was regarded as not being acceptable. For research 1 and 2 dealing with level of awareness and utilization respectively. Real limit of numbers was used for interpretation of data as shown below

Scale	Scale point	Lower limit	Upper limit
Very high (VH)	4	3.50	4
High (H)	3	2.50	3.49
Low (L)	2	1.50	2.49
Very Low (VL)	1	1.00	1.49

RESULTS AND DISCUSSION

This chapter presents results of the data analysis and discussion of findings based on data collected for the study. The descriptive statistics of mean score and standard deviation were used to answer the research questions.

Research Question 1: What is the extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Table 1: Mean Responses on the extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. N=344

S/N	To what extent:	VH (4)	H (3)	L (2)	VL (1)	Mean	S	Remark
1.	have you observed the use of Google classroom in the teaching and learning?	50	70	110	114	2.20	0.48	Low
2.	have you heard about the use of Google classroom in teaching and learning?	55	65	120	104	2.21	0.49	Low
3.	are you aware that Google Classroom is an excellent medium for social interaction (lecturer vs students and student vs student)?	49	79	100	120	2.20	0.48	Low
4.	are you aware that Google Classroom is user friendly?	55	69	100	120	2.20	0.48	Low
5	are you aware that Google Classroom helps in submitting assignment on time?	50	71	100	120	2.10	0.48	Low
6	are you aware that Google Classroom is cost free?	40	70	110	124	2.10	0.45	Low
7	are you aware that Google Classroom is smart phone friendly?	50	60	100	134	2.10	0.45	Low
8	are you aware that Google Classroom is time saving?	50	54	100	200	2.10	0.45	Low
	Pooled mean					2.20		Low

Table 1 reveals that items 1-8 have mean values ranging from 2.10 to 2.21 which is within low level in the real limit of numbers. The pooled mean of 2.20 means that there is low extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Research Question 2:

What is the extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?

Table 2: Mean Responses on the extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. N=344

S/N	To what extent:	VH (4)	H (3)	L (2)	VL (1)	Mean	S	Remark
1.	Do you use mobile devices to create Google account for illustration to the students?	4	20	40	280	1.27	0.13	Very low
2.	Have you used Google Classroom as a grading system in monitoring the performance and understanding of the students?	4	10	40	290	1.21	0.10	Very low
3.	Is Google Classroom easy to use?	0	14	40	290	1.20	0.10	Very low
4.	Can Google Classroom be used to motivate students and enhance learning initiative	3	14	37	290	1.23	0.11	Very low
5	do you use mobile devices to sign on the Google Classroom account	8	9	30	297	1.21	0.10	Very low
6	are you good with the creation of class on Google Classroom?	0	0	54	290	1.20	0.10	Very low

7	do you use Google to create assignment to be answered by the students	1	1	2	340	1.02	0.01	Very low
8	do you receive or send answers to assignment questions on Google Classroom?	0	1	2	341	1.01	0.00	Very low
9	do students find it easy accessing Google drive folder for Classroom materials on Google Classroom	0	0	1	343	1.00	0.00	Very low
10	are you familiar with attaching outline courses and lesson plan on Google Classroom?	1	2	1	340	1.02	0.01	Very low
	Pooled mean					1.26		Very low

Table 2 reveals that items 1-10 have mean values ranging from 1.00 to 1.27 which is within very low level in the real limit of numbers. The pooled mean of 1.26 means that there is a very low extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Research Question 3:
What are the perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?

Table 3: Mean responses on the perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. N=344

S/N	Factors	SA (4)	A (3)	D (2)	SD (1)	Mean	S	Remark
1.	Shortage of science and technological based teachers and personnel	300	40	4	0	3.86	0.96	Accepted
2.	Cost and access to the Internet	320	20	3	1	3.91	0.98	Accepted
3.	A lot of the students sometimes encounter technical problems	300	43	1	0	3.86	0.96	Accepted
4.	Learners' difficulties in sharing and editing problems	304	40	0	0	3.88	0.97	Accepted
5	Lack of technical-know-how on the part of the students who had no experience in trending technology.	320	20	4	0	3.91	0.98	Accepted
6	Use of Google classroom makes new user feeling confused or needing more time to deal with it	310	30	3	1	3.88	0.97	Accepted
7	Lack of governmental intervention towards provision of basic technological facilities in the tertiary institutions	290	50	3	1	3.82	0.95	Accepted

Table 3 reveals that items 1-7 have mean values of 3.86, 3.91, 3.86, 3.88, 3.91, 3.88 and 3.82 respectively which are all above the benchmark of 2.50. It can thus be concluded that based on the perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State, the following were observed: shortage of science and technological based teachers and personnel, cost and access to the Internet, a lot of the students sometimes encounter technical

problems, learners difficulties in sharing and editing problems, lack of technical-know-how on the part of the students who had no experience in trending technology, use of Google classroom makes new user feeling confused or needing more time to deal with it and lack of governmental intervention towards provision of basic technological facilities in the tertiary institutions as perceived factors militating against the proper use of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Research Question 4:
What are the ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State?

Table 4: Mean responses on the ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. N=344

S/N	ITEM	SA (4)	A (3)	D (2)	SD (1)	Mean	S	Remark
1.	Adequate funding of the Federal tertiary institution in Nigeria	340	4	0	0	3.98	0.99	Accepted
2.	Provision of basic technological facilities needed by lecturers in carrying out their duties	250	50	40	4	3.58	0.89	Accepted
3.	Good policy formulation and implementation in the tertiary institutions	260	50	31	3	3.64	0.91	Accepted
4.	Ensure safety of available e- learning facilities	304	38	2	0	3.87	0.97	Accepted
5	Encouraging good students' attitudes toward these facilities	200	140	3	1	3.56	0.89	Accepted
6	Conducting special training program to improve lecturers' knowledge of trending technologies	200	140	4	0	3.56	0.89	Accepted
7	Appropriate orientation of students on the need to develop their knowledge of Google classroom	300	39	4	1	3.85	0.96	Accepted

Table 4 shows that respondents agreed on all the items as items 1 to 7 all had mean values of 3.98, 3.58, 3.64, 3.87, 3.56, 3.56 and 3.85 respectively which are all above the benchmark of 2.50. This is an indication that the ways to enhance the use of Google classroom in teaching and learning of Agricultural Education include: adequate funding of the Federal tertiary institution in Nigeria, provision of basic technological facilities needed by lecturers in carrying out their duties, good policy formulation and implementation in the tertiary institutions, ensure safety of available e-learning facilities, encouraging good students' attitudes toward these facilities, Conducting special training program to improve lecturers knowledge of trending technologies and appropriate orientation of students on the need to develop their knowledge of Google classroom

Discussion of Findings
This section dealt with the discussion of findings arrived at by this study and was discussed in line with the findings from research questions formulated for the study as follows:

Research Question 1 sought to find out the extent of awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. This was analyzed in Table 1 which shows that the respondents to a low extent are awareness of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. This is in disagreement with Iftakhar (2016); Shaharanee et al.

(2016), who found in their study that the respondents have very high awareness of the use of Google Classroom as an excellent medium for social interaction between lecturer and students and between student to student.

Research question 2 was on the extent of utilization of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. This was answered in Table 2 which reveals that the respondents agreed that there is very low extent of utilization of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

This finding is contrary to reports by Iftakhar (2016); Shaharanee et.al (2016); Rossytawati (2018) where utilization of google classroom was greatly indicated. The contradiction may be due to the fact that the respondents used for this study in first place were not aware of google classroom. Moreover, the geographical scope of this study may have also contributed to the very low utilization of google classroom.

Research Question 3 was asked to investigate the perceived factors that could militate against the proper use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. This was analyzed in Table 3, it reveals that factors such as shortage of science and technological based teachers and personnel, cost and access to the Internet, a lot of the students sometimes encounter technical problems, learners difficulties in sharing and editing problems, lack of technical-know-how on the part of the students who had no experience in trending technology, use of Google classroom makes new user feeling confused or needing more time to deal with it and lack of governmental intervention towards provision of basic technological facilities in the tertiary institutions were the identified perceived factors militating against the proper use of Google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. This finding is in cognizance with that of Rossytawati (2018); Shaharanee et.al (2016) who also reported similar factors militating against the proper use of Google classroom.

Finally, research question 4 sought to find out the ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria. This was analyzed in Table 4 which shows that there are possible ways of enhancing the use of Google classroom in teaching and learning of Agricultural Education. The possible ways cut across; adequate funding of the Federal tertiary institution in Nigeria, provision of basic technological facilities needed by lecturers in carrying out their duties, good policy formulation and implementation in the tertiary institutions, ensure safety of available e- learning facilities, encouraging good students' attitudes toward these facilities, Conducting special training program to improve lecturers knowledge of trending technologies and appropriate orientation of students on the need to develop their knowledge of Google classroom.

This is in agreement with Banful et al. (2010); Iftakhar (2016); Rossytawati (2018); Shaharanee et.al (2016) , the authors in their various studies also reported that the primary ways to enhance the use of google classroom in teaching and learning are appropriate orientation of students on the need to develop their knowledge of Google classroom and that provision of basic technological facilities needed by lecturers in carrying out their duties will in a long way enhance the use of google classroom in teaching and learning.

SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTION FOR FURTHER STUDIES

Summary

This study investigated the awareness and usefulness of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. The study adopted descriptive survey research method. The target population for the study was 337 undergraduate students and 18 lecturers in the Department of Agricultural Education of Joseph Sarwuan Tarka University, Makurdi. All members of the population (355) were used as sample for the study as they were all accessible and manageable. Three hundred and fifty-five (355) copies of the instrument were distributed, 344 copies representing 96% were retrieved and analyzed while 11 copies were lost. The instrument was constructed and given to an expert in the Department of Agricultural Education, some of the inadequacies of the instrument were reviewed based on the criticism received. As a result of this, a modified question was prepared. The analysis of result revealed that the respondents agreed to a great extent they are not aware of Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. The respondents also disagreed to a high extent that Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State is highly utilized. The study also revealed that use of google classroom is faced with factors such as shortage of science and technological based teachers and personnel, cost and access to the Internet, a lot of the students sometimes encounter technical problems, learners' difficulties in sharing and editing problems, lack of technical-know-how on the part of the students who had no experience in trending technology, among others.

Ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State are numerous. These possible ways are related to adequate funding of the Federal tertiary institution in Nigeria, provision of basic technological facilities needed by lecturers in carrying out their duties, good policy formulation and implementation in the tertiary institutions, ensure safety of available e- learning facilities, encouraging good students' attitudes toward these facilities, among others.

Conclusions

Based on the findings of the study, the researcher concluded that there is need for sufficient availability of instructional materials needed for google classroom utilization in the teaching and learning Agricultural Education. The study reported that to a very high extent, the students and lectures are not aware of and also do not utilize Google Classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State. However, the study indicated that despite the importance of google classroom in the teaching and learning of Agricultural Education, the use of it is faced with a number of factors such as shortage of science and technological based teachers and personnel, cost and access to the Internet, and that a lot of the students sometimes encounter technical problems. Furthermore, the study reported adequate funding of the Federal tertiary institution in Nigeria, provision of basic technological facilities needed by lecturers in carrying out their duties, good policy formulation and implementation in the tertiary institutions, among others as possible ways to enhance the use of google classroom in teaching and learning of Agricultural Education in Joseph Sarwuan Tarka University, Makurdi, Benue State.

Recommendations

The following recommendations are made from the findings;

1. Universities should encourage their lecturers to start using Google Classroom as a medium of teaching their students.
2. Universities should organize a seminar and workshops for their lecturers to train them on the use of Google Classroom as a medium of teaching
3. Universities should however advice their students on Google Classroom maximization; students are expected to use Google Classroom properly and creatively; because the way students use a tool is what makes the difference. The way students properly use Google Classroom can make learning better; more engaging, and more student-centered.

Suggestions for Further Studies

This study can be replicated in other geopolitical zones within the country; further research should be conducted in evaluating perceived negative influence of the utilization of google classroom in the teaching and learning of science subjects in senior secondary schools in the country.

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