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## RESEARCH PERIODICALS

# TABLE OF CONTENTS

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# Public Policy for Regenerative Medicine in Brazil: Changes in State Capacities

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**Abstract:**

Conclusions of ongoing research projects on regulation frameworks, institutional and State capabilities, innovation, media coverage and patient organizations´ practices are the main context of this paper on regenerative medicine in Brazil, comparative to the sector´s global evolution. The present study´s main purpose is to map historically, in a brief manner, trends in State agencies´ capacities to develop main public policies and normative actions on innovation and regulation in the sector and show controversies and their unresolved gaps and conflicts. It aims at showing the contradictions existing between the high quality of local scientific and medical development, production, distribution and implementation of advanced therapies and the problems faced by State agencies for therapy approval and their full adoption within the public health system, in ways that provide wide public access. The study also considers the incoherence and duplication of efforts found within and between relevant public agencies, the lack of adequate training in the area among key policymakers and their scarce knowledge on strategies directed to media coverage and general public engagement. Their development and the adoption of regenerative medicine by the public health system could become some of the main short-term challenges for the State in Brazil, in the short and medium terms. The paper concludes that the country would benefit from declaring regenerative medicine as a strategic sector for scientific and industrial development in the near future and ends mentioning some policy recommendations that could contribute in that direction.

*Keywords: regenerative medicine, cellular therapy, State capacity, health policymaking, molecular genetics, rare disease patient organizations, State agencies, public health system.*

## INTRODUCTION

Regenerative Medicine (RM), a subsector of stem cell research and molecular genetics, has transformed conventional medical practices (Webster, 2011). RM focuses on the repair and regeneration of cells, tissues and genes, using different kind of stem cells removed from human bodies and generally reproduced *in vitro* (Mason& Dunnil, 2008). Cellular and genetic therapies are often applied jointly and they have been classified as advanced therapies (AT).

They are often described in media coverage in overly optimistic ways and give unrealistic hope of readily available new cures, especially, to treat fatal or rare diseases (Bubela et al., 2012). However, the risks and uncertainties in the manipulation of biological materials that are alive are still a matter of scientific and social concern (Martin et al., 2008). RM has required new forms of regulation of biological materials and products as well as, the updating of some of the State capacities to handle and implement new cellular and genetic therapies, at the public, private, local

and supranational levels (Morrison, 2012; Faulkner, 2016). This new medicine has also led to the inclusion of new social sectors (stakeholders) in the area´s governance.

The present study, summarizes conclusions from previous and ongoing research on RM in Brazil undertaken in comparison to practices in other countries– especially, to the United States of America and the United Kingdom, two world leaders in RM. Among those studies can be mentioned: a) a research project self-coordinated and financed by the Foundation for the Support to Research of the State of Rio de Janeiro (FAPERJ) in the position of Visiting Senior Professor (2009-2010) and by the National Council of Scientific and Technological Development  (CNPq – Universal Call for Grants,2009) between 2010 and 2012: 'Development of Governance Capacities: Social Visions and the Debate on Stem Cells in Brazil'; b) the research project: 'Public policies on innovation and regulation in stem cell research: a comparison between the cases of Brazil and the United Kingdom´, developed as Senior Researcher of the CNPq between 2018 and 2019; c) the ongoing research project : 'State and supranational capacities in innovation, governance and regulation in Regenerative Medicine:  The experiences of Brazil, Argentina, the USA , the UK and Canada', part of the INCT/PPED/IPEA network since 2020 and, at present, also supported by the a Postdoctoral level scholarship from the CNPq ( 07/2023-06/2024).

 The present study has the aim of:
- Mapping the main public policies and regulations in RM in Brazil since its beginnings till today.
- Discussing the main State capabilities and activities in RM throughout time and showing gaps, incomplete aspects and conflicts between agencies, their capacities and forms of regulation.
- Suggest recommendations on public policy for RM in Brazil for the near future.

## RESEARCH METHODS

Methodologically, the study is based on a bibliographical and documental revision, using mainly secondary data and on a qualitative analysis of information, as well as, on limited quantitative analysis of statistical data. More specific information was raised, specially from the websites of the main innovation, regulatory, legislative and ethic review public agencies and institutions that directly or indirectly deal with RM, as will be shown in the text. This data contributed to the construction of the brief historical perspective on the main events in RM in Brazil presented in the next section.

Semi-structured interviews - of approximately one hour duration- were conducted, at intervals, between 2019-2020 to key informants (5) and 15 to Brazilian RM leaders. Thirty interviews had been previously carried out, between 2010 and 2012, with a sample of: local scientists, policy makers and representatives from civil society.  Another six interviews were developed more recently with leading policy makers from Brazilian public agencies (2021-2022). Moreover, 28 interviews with representatives of patient and civic society organizations were developed between 2021 and 2022.

These interviews were analysed for context, content, narrative and emotional connotations, as well as, their implicit social values, following what Mulkay (1993, p. 723–724) has defined as "discourse regularities", meaning:  the forms and contents that are constructed according to social and cultural beliefs that reveal the interconnections between the basic views of the

interlocutors. Narratives from open-ended questions were analysed looking for convergence, divergence, dissonance and smaller variations in dealing with key topics.

This analysis focused on recurrent themes found in the secondary data previously gathered, upon categories such as:: trends in financial budgets and modalities, levels of coordination between State agencies, training programmes for policymakers, flaws in innovation, regulation and monitoring, design of RM aims and objectives, type of State dynamic capacities (quality and coherence of public policies and actions, partial or wide policy reach, legitimation of public decision making processes, leaderships´ strategies, as well as, operational and administrative skills) and the engagement dynamics of different social sectors. Results were reviewed and coded qualitatively following the methods prevailing in grounded theory (e.g., Bonilla-Garcia et.al. (2016); Cutcliffe (2001); Harris (2014)).

### BRIEF HISTORICAL ACCOUNT OF THE MAIN PUBLIC POLICIES IN RM

The main events in RM public policy in Brazil, since its beginnings, will be summarized next, showing recent developments and institutions in this field. The section does not intend to present a complete picture of the historical evolution of the local scientific, medical and regulatory progress, though it illustrates its key moments. [For a more complete description see, The author, 2023].

The beginnings of RM could be located around 2001 with the creation of the first public bank of umbilical cord blood and placenta (BPSCUP), based at the National Cancer Institute (INCA). Between 2003 and 2009, the Health Ministry (MS) and the National Council for Scientific and Technological Development (CNPq) – within initiatives located its Department of Science and Technology (DECIT) and its Secretariat for Science, Technology and Innovation and Industrial Complex (SECTICS) - launched a number of calls for research grants, fellowships and scholarships on stem cell research. In 2004, the MS contributed to the establishment of the Public Network Brazil Cord, banks for the transplant of bone-marrow and umbilical cord cells to patients. During the design of the National Agenda of Priorities in Health Research (ANPPS), in that same year, alongside the scientific community, RM was included for the first time.

A big step was taken at the national level with the design and implementation of a large multicentric randomized clinical trial on different types of heart disease using adult stem cells (EMRTCC) and covering clinical phases 2 and 3. It was financed jointly by the Ministry of Science, Technology and Innovation (MCTI) and the MS. This trial included nationally, 1 200 patients and 30 centres and lasted from 2004 to 2012. Though arriving at some interesting results regarding heart conditions provoked by Chagas disease, its Coordinator announced that more basic and clinical stem cell research would be required to meet the necessary standards to develop efficient clinical therapies (Zorzanelli et.al, 2017). However, it became a quite well-known trial at the global level, as only Germany had been previously responsible for performing a similar kind of expanded clinical trial.

The stem cell initiatives where somewhat stalled between 2005 and 2008 due to internal debates on the use of embryonic stem cells for research, a sensitive issue in Brazil. In 2005, the Biosecurity Law (Lei nº 11.105) was approved by Congress. This law considered the use of both genetically modified organisms (GMO) and embryonic stem cell research, under certain conditions. At that time, the Technical National Commission of Biosecurity (CTNBio) was created within the MCTI, as a technical consultation body to the Federal Government, for the implementation of the National

Policy on Biosecurity. It prioritized evaluations on GMO and the environment, but also the protection of human health and living organisms. However, in 2008, a Direct Action of Unconstitutionality (ADI 3.510) was presented to the Federal Supreme Court (STF) against stem cell research with embryonic cells, on moral and religious grounds. This led to an extended public debate and an open public audience. (See, The author, 2011; Cesarino, 2007, for further details). Two groups were central in that debate: those against their use, associated to the Catholic and Evangelic Churches, including also a minority of specialized scientists/medical doctors, and another one, in favour of that type of research and integrated by the majority of the scientific specialists, representatives from organized civil society groups, patient organizations and individual patients. Finally, the controversy was resolved in favour of the continuation of embryonic stem cell research, though only with the use of cells extracted from eggs frozen for over three years since the law was passed.

Once this issue was legally resolved, there was a need for specialized scientists to collaborate more closely between them in the studies being developed. With this aim, in 2008, the National Network of Cellular Therapy (RNTC) was founded to support those data exchanges and also eight new Centres of Cellular Therapy (CTC), to develop research grade stem cell lines. Moreover, new public calls for grants for research centres and laboratories were launched. These initiatives were financed by the MS (DECIT) in collaboration with the MCTI, the CNPq, the National Bank of Economic and Social Development (BNDES) and the Agency for the Funding of Studies and Projects (Finep), i.e. by all the main agencies for funding science and technology at the national level.

The following year the area kept expanding through the signing of a Cooperation Agreement between Brazil and Argentina (PROBITEC), for the exchange of students and professionals and collaboration in joint research projects. The decision was taken jointly between the MS (DECIT) of Brazil and the Ministry of Science, Technology and Industry of Argentina. It became a very successful endeavour that was periodically renewed.

By 2010, the country was ready to launch its first bank of embryonic stem cell lines developed locally and called LanCE- National Laboratory of Embryonic Stem Cells. The bank later on, started to work also with iPS lines (induced pluripotent stem cells). This was an initiative launched between the Federal University of Rio de Janeiro and the University of São Paulo.

That same year there was also the establishment of the National Centre for Structural Biology and Bioimage (CENABIO) supporting preclinic research. It was jointly funded by the Ministry of Education (MEC), the Universal System of Health (SUS) and the Chan Zuckerberg Initiative. The National Bank for Pluripotent Induced Stem Cells (iPS)- Patient Specific, was created in 2011 by the National Agency of Sanitary Vigilance (ANVISA) and the UFRJ. The following year, a new Bank was also established for iPS between the UFRJ and the USP. These cells began to be locally and globally more widely used in research and therapy, as they present less moral controversy, compared to embryonic stem cells and have relatively similar effects.

Since 2012, the MCTI and other public agencies took several new initiatives regarding the protection of animals, such as, the creation of the National Network for Alternative Methods (RENAMA) – for the substitution of animals for experimentation in the laboratories; the approval of the normative resolution (RN) n° 17, 2014, by the National Council for the Control of Experiments with Animals (CONCEA); the RN n° 18, of 2014, that considers seventeen alternative

mandatory methods for the use of animals in research, as well as, the RN nº 31 of 2016 that added seven other methods.

In 2012, given the fast expansion of the area, ANVISA created both, the Technical Chamber of Advanced Therapy (CAT), as its consultative branch for RM, as well as, the Brazilian Registry for Clinical Trials (ReBEC) linked to the United Nations Registry. However, the first lacks adequate representation of organized civil society. Registration became mandatory for the performance of all new clinical trials in Brazil. These had previously only some been registered at the Clinicaltrial.gov USA platform, that does not check for the technical or ethical approval of the trials announced.

A number of Normative Resolutions (RDC) had already been passed by ANVISA, between 2004 and 2013, to prepare for the local consolidation of RM regarding regulatory procedures. These were, for example, the approval of RDC 21 that contributed to the tertiarization of clinical trials by specialized consultants, the RDC 36 21, that simplified the directives on good clinical practices and the RDC 38 for the approval of medicines with "expanded access to patients", compassionate use and use post clinical trials.

In 2014, the MCTI, the MEC, the CNPq and the Coordination for the Improvement of Higher-Level Personnel (CAPES) launched a pioneer training and research programme called 'Science without Borders', to promote the internationalization of local S& T, innovation and competition through scientific exchanges and professional/student international mobility, that positively impacted upon RM.

In order to promote the culture of human tissue in 3D studies, in 2015, the project "Human–on-a-chip" was established at the National Laboratory of Biosciences in Campinas, São Paulo. This facilitated enormously the testing of medicines, generated from biological materials extracted from specific individuals and reproduced three dimensionally. The new technique facilitated the path towards 'personalized medicine'. The programme was jointly supported by the MS, the MCTI and the CNPq.

To further promote the path towards translational medicine in RM, the Federal Brazilian Constitution of 1988, that prohibits the commercialization of the human body or its parts in paragraph 4° of article 199, was reviewed in 2018, by the Federal Attorney´s Office together with Anvisa. Their final Report n° 12/2016 PF-Anvisa/PGF/AGU, then allowed for the use of biological materials in the development of stem cell and genetic therapies.

The expansion of the legislative approach allowed for the further clinical development of advanced therapies (AT). These were only defined as such in Brazil that same year, i.e. each as a Product of Advanced Therapy (PTA) - that comprise cellular, genetic therapies, and tissue engineering. AT were divided into two classes, I e II, those less and those highly manipulated. For each category different norms of production and implementation became mandatory, as the first class (I) – the use of a patient tissue for the culture of stem cells and reintroduction into his own organism or autologous use - presents less risks and more security than the second class (II). The last type is generated from tissue provided by multiple donors and are eventually applied to larger groups of patients, or else, are commercialized 'off-the-shelf', for example, skin to cure burns. This big change of course in local regulation was complemented that same year by the issuing the

RDC 214, that defines good clinical practices in research with human beings (BPF) and the RDC 260 that describes standard protocols for the development of clinical trials in AT.

In 2019, through a joint effort between some of the main public Universities, such as, UFRJ, USP, UERJ, other public institutions – Anvisa, FAPERJ, INCA - and with the support of the PNUD, the mapping of the genetic profile of the immune system of 4 million Brazilians was started. This programme was located at the National Bank of IPs cells. In that same year, with the purpose of aiding specialists in applying the new regulatory framework correctly and also, for the analysis of *dossiers* of clinical trials and/or the registration of new products, the National Network of Specialists (RENETA) was formed by Anvisa integrating 30 reviewers. Given the importance of Big Data in this field and in other health issues, the Action Plan for the Monitoring and Evaluation of the Digital Strategy of Health in Brazil was also set up.

In 2020, a number of different regulatory measures were taken. Two genetic therapies were approved by Anvisa: Luxturna (Novartis Biosciences) for retina hereditary dystrophy and Zolgensma (developed by Novartis Biosciences) for muscular spinal atrophy among children less than 2 years old. The RDC 338 was passed to regulate the adoption of AT in the public health system and its commercialization in Brazil. There were also other new Research Grant Calls for industrial innovation in RM and designed by the Brazilian Enterprise of Industrial Innovation (EMBRAPII). Also, the MS in collaboration with the MCTI, the CNPq, the BNDES and Finep, as well as with the scientific community, announced an important Call for Grants for research projects on AT, of the order of 48 million reais.

Another milestone involved the creation of the National Programme of Genomics and Precision Health ("Genomas Brasil") through the Resolution 1949, that involves two different stages. First, stage 1.0 to sequence the genome of local people with rare, heart, infectious diseases and cancer for diagnoses and prevention and second, the stage 2.0 of AT for therapeutic aims. The programme, financially supported by the MS and the MCTI, was launched at the President´s Office. The investment initially proposed was of 160 million reais and different international partnerships were signed. One of the most important agreements on bilateral scientific cooperation in AT was established between the MS and the United Kingdom, in 2022. In that same year, a new genetic therapy developed by the firm Novartis Biosciences was approved by Anvisa, i.e. Kymriah used for the treatment of refractory or lymphoblastic leukaemia.

The next section will explore, given this type of progress in RM in Brazil, what has been the State´s positioning regarding interaction between agencies, the development of normativity and the spaces that remain open to design further measures and/or for change.

## THE EVALUATION OF STATE PERFORMANCE: PROGRESS, LACUNAE AND/OR UNSOLVED TOPICS

A group of State dynamic capacities in Brazil have been gradually evolving, most especially, over the last ten years. Dynamic capacities have been defined as those that target concrete problems, especially, in contexts of risks, uncertainty and permanent transformation (Kattel & Mazzucatto, 2018). At the very beginning of RM in Brazil, during the last decade, there was a synchronized State coordination between the MS, the MCTI, Finep and BNDES, all of them focused on promoting collaborative networks between sectors of the specialized scientific community.

Initially, there was also a strong dependency of the relevant State agencies from the substantive contributions of the emerging public scientific sector, in relation to the definition of strategic priorities in RM within basic and preclinical research topics, for supporting the modernization of equipment and infrastructures, as well as, towards updating regulation. But after that initial stage, RM key policymakers started training activities to specialize in RM, for example, they participated in national level training programmes, established collaboration between representatives of different agencies, undertook visits to key international institutions, as well as, organized internal debates between different agencies relating regulation and organizational experience. Policymakers also promoted international scientific partnerships and participated in the upgrading of the ethical, regulatory and juridical framework in RM, for example, discussing the Law Project (PL 7082), about developing a new System for Ethics in Clinical Research.

At present, operational capabilities among policymakers have substantively improved, in spite of there still being an important deficit in relation to clinical research monitoring, the manufacturing of therapeutic products and the management of the large volume of data commonly generated by this type of research (Big Science). Misinformation and dis-information also contribute to hinder the systematic evaluation of results in the implementation of RM public policies. Lacunae in public action harms the development of State planification based upon evidence and transparent disclosure of new initiatives and results to the general public. As a result, it indirectly reduces useful public engagement.

However, mission-oriented public policy has been scarce in RM. This type of policy entails the resolution of concrete problems creating conditions to access new markets through systemic actions with specific objectives and it is fundamental in the formulation of policies in any frontier sector, such as RM, that presents still a lot of risks and uncertainties and is continually changing. (Mazzucatto,2017; Kattel & Mazzucatto, 2018; Edquist& Zabala- Iturriagagoitiaa, 2012). Thus, RM public policies have had limited reach, are subjected to high experimentation and conducted in quite a disorganized or partial manner and, in some cases, with parallel, contrasting or overlapping initiatives taken by different public agencies, for example, in the case of funding. Moreover, these policies are very far from attaining global standards on RM (The author, 2014). Furthermore, the sector lacks long term financial stability and sufficient finance for basic, pre-clinical and clinical research. This is largely because research projects tend to be funded mainly through the Calls for Grants and/or Scholarships of the CNPq (see, Table 1) or of State-level research agencies, that support every research project approved just for short periods of time, usually one to two years, - too short a time to reach substantive results in RM. The choice of projects lacks a direction towards national strategic priorities on RM.

**Table 1: Distribution of funding for RM among agencies and number of projects in stem cells, cellular therapy and regenerative medicine (2002=04/2021)**

| State Agency | Value (R$) | % | Number of projects | % |
|---|---|---|---|---|
| Ministério da Saúde (DECIT-SUS) | 150.772.638,15 | 32,24 | 257 | 15,52 |
| BNDES | 46.135.329,00 | 9,86 | 7 | 0,42 |
| FINEP/MCT | 88.410.031,34 | 18,90 | 34 | 2,05 |
| CNPQ | 182.354.707,59 | 38,99 | 1358 | 82,00 |
| Total | 467.672.706,08 | 100 | 1656 | 100 |

Source: The research.

State action legitimation has varied throughout time. There was a moment when RM received full support and had an important expansion – during the two periods of President Lula Da Silva's government and the first period of President Dilma Rousseff's. Both governments were sustained by similar hegemonic coalitions, i.e., stakeholders' groups that included sectors of organized civil society (Gaitán & Boschi, 2016). Those coalitions acted following a specific type of convention, based on a 'developmentalist' style, to deal with technological and industrial progress. A convention has been defined as, "a collective cognitive devise, formed by codified and tacit knowledge that allows to hierarchize problems and solutions, as well as, facilitate coordination between social actors" (Erber, 2011, p. 53).

By contrast, since the second government of President Dilma Rousseff, policy actions favourable to RM were reduced. There was a still more systematic weakening of the support system of RM in the following two government periods–those of Presidents Michel Temer and Jair Bolsonaro – whose hegemonic coalition was based on a new set of elite social actors that promoted a neoliberal ideology and literally attacked science and education. This more recent period, is characterized by strong budget cuts in most public agencies, such as, at the MCTI and the MEC. Those cuts included: diminished funding for ongoing projects, a substantive reduction in the number of research calls for new RM projects, substantial cuts in financial aid for students' and professionals' training, as well as, for the international exchange of students and professors in associated careers (Interview conducted with Rodrigo Rocha, Innovation Superintendent at Finep, May 5, 2022) (Reis & Macário, 2020).

At present, there is a new wave towards a more effective coordination of public policy between those agencies that support funding and those that develop regulation, even though, policies still present many flaws, as observed, for example, in the fragmentation of sources of funding (Table 1). Lack of a centralized public program on RM, has also contributed towards excessive bureaucratization of the ethical and technical approval of AT projects. Vacuums and discontinuities in policy implementation are mainly found in the definition and follow up of biological materials to start research, the incomplete regulation of clinical trials and of good manufacturing AT practices- even when norms on these issues have been recently passed. In the last years, agencies have tried to improve researcher's training in new regulatory procedures for grant applications (See, the setting up of the internet-based network RENETA by Anvisa https://www.reneta.org.br/).

Administrative and operational State capacities are out of pace with the fast development of this emerging scientific and medical area. Local scientific breakthroughs in RM are reflected in, for example, the large amount and good quality of Brazilian scientific researchers' publications or those studies co-authored with foreign professionals and published in internationally prestigious journals (The author, 2013; 2021; Machado, 2021). Moreover, the development of operational capacities within some of the government agencies has taken place only after the shaping and expansion of the institutions that form the main public scientific structure. For example, there is a profound neglect in governmental design of upgraded measures for continuous planning and monitoring within the CTC and the Centres of Excellence in Genetics (Marin & Paganini, 2018). The sector has largely self-evaluated its own activities. There is an absence of effective regulatory measures within State action to support manufacture of nationally generated allogeneic AT (e.g. Silva Junior et.al., 2018; Bizon Carlas et.al., 2018; Valadares Folgueiras-Flatschart et al., 2018; Cavaleiro da Costa et al., 2018; Miranda Parca et al., 2018). In the case of autologous cellular transplants, that have a longer tradition in Brazil, better control measures have been already

implemented by the State. Misinformation and dis-information also contribute to hinder a systematic evaluation of results in the implementation of RM public policies. Lacunae in public action harms the development of State planification based upon evidence and transparent disclosure of new initiatives and results to the general public. As a result, it indirectly harms productive public engagement. The majority of the academics working in RM lack deep involvement with the general public, as well as, with private hospitals and private national or foreign firms, except in a few cases, some associated to multicentric clinical trials. No relevant mechanisms have been designed to offer incentives that would strengthen the relations between hospitals and academia, between academia and firms and between foreign and national partners. Moreover, stage 3 clinical trials are yet not too frequently performed in Brazil and usually, depend upon international sponsors that do not work too closely with local research centres.

In spite of a longstanding programme for the implementation of public/private partnerships, based on the legal norms established by the Technological Innovation Law of 2004 (Lei de Inovação Tecnológica 10.973) and the Law of Goods of 2005 (Lei do Bem 11.196), neither law discusses the specificities needed to adjust to the differential characteristics of AT. Both industrial and technical capacities in RM to attain therapy manufacture, present important gaps when compared with those prevalent in advanced countries – see, for example, the functions of the Gene and Cell Therapy Catapult in the United Kingdom https://ct.catapult.org.uk/ and the studies of authors, such as, Gardner & Webster (2018) and Acero (2019; 2020).

In the present study, BNDES´s interviewees commented that the firms´ demand for refundable credits is almost inexistent, because AT are still considered as 'services' – instead of products- contrary to the last resolutions approved by da Anvisa. Moreover, in the case of clinical trials, national firms show yet no interest to invest. Finep is the agency that tends to finance the whole innovation spectrum of a set product, i.e., until the product reaches the market with technological maturity. It has had an initial role of structuring RM, as well as, recently approved aim-specific project funding for private hospitals. The non-refundable or 'collaborative' funding offered by Finep has also been substantive and mainly bestowed to institutes of science and technology (ICT) in partnership with firms. The institution has also granted refundable economic credits to start-up firms in RM- even though, in this case financial aid has been quite limited.

In spite of these strategies, recent concrete State actions for the promotion of innovation capacity have suffered from the persistent dismounting of the resources for the National Fund for Technological Development (FNDCT), since 2015. (Reis& Macário, 2020) - official policy of President Jair Bolsonaro´s government. Investments in science and technology have been reduced to the order of 600/700 million reais - an amount that, according some of our interviewees, "would not even pay for the scholarships from CNPq".

One of the weakest spots and a matter of concern and of some urgency relating State capacities in health, consists in the adequate preparation of the public health system (SUS) for the correct implementation of AT. Upgrading of SUS´s functions suitably should include: the specialized training of medical doctors, health technicians and nurses, the reform of infrastructures and transport, the gathering and storage of clinical data and a wider participation of patients and patient organizations as key informants. Moreover, in the case of genetic therapy and bioinformatics associated to RM, the country even lacks the number of specialized professionals required.

However, SUS counts with the capabilities and the institutions to develop the adoption of new therapies, such as: the National Commission for Technology Incorporation (Conitec) with 123 members, created in 2011, and the Brazilian Network for Health Technology Evaluation (Rebrats), which runs 24 Nuclei of Technological Evaluation in Health (NATS), since 2009, within public hospitals to coach management strategies. These instances need only to be upgraded and suited to AT demands. (Uziel,2020; Caetano et al., 2017).

All of the public institutions analysed up to now have recently organized debates and seminars to discuss new models for the adoption of AT in the national level, for example, the viability of different cost reimbursement systems for AT, the potential for the design of public models for cost reimbursement based on shared risks between stakeholders and /or on the results obtained by treatments. But the design of alternatives for the reimbursement of costs by the private health plans and of the fixing of adequate market prices for AT are still unresolved matters. Thus, it is important to further build up the necessary State capacities for the construction of social consensus relative to these topics.

However, the innovation RM pathway adopted in Brazil presents a significant flaw: the limited inclusion of organized civil society - beyond the scientific and medical community and of some representatives from key firms, especially from start-ups. This acts as a big obstacle within the State, as it lacks awareness of the problem, as well as, scarcely trains its policymakers to design public engagement strategies. These are largely restricted to public consultations by internet, announced in the websites of the relevant agencies and scarcely publicized. Inclusion of stakeholders' opinions becomes extremely selective in those consultations and their participation within assessing bodies and technical chambers of the agencies in charge is very reduced. Given this situation, places for formal discussion and debate with the integration of those different social organizations' views become an exception. Thus, patient organizations of rare diseases interviewed for the present study, reveal a continuous need to actively verify the implementation of public policies already designed and legalized by government (The author, 2022). These associations have to exert permanent pressure on the State to have their rights to access AT guaranteed, even when some products, e.g. three genetic therapies, have already been approved by Anvisa for local commercialization, though they are to be acquired privately (i.e., out of SUS).

Adequate training of policymakers in public and media engagement, the reduction of the evaluation periods of health therapies and wider public access to medications, could also contribute to reduce the "judicialization" of health associated to RM, in the acquisition, distribution and utilization of AT (Souza Soares & Deprá, 2012). Wider disclosure of information, could also contribute to avoid medical tourism towards foreign countries for patients looking for RM treatments unavailable in Brazil – medical tourism that has expanded globally (Sipp et.al., 2017; ISCT, 2018; Rivas et.al., 2018).

The uncertainties and risks that frequently characterize AT and the real time periods between scientific and medical experimentation and the approval of products and adoption by SUS, are aspects that are practically absent from contemporary Brazilian public debates. In this sense, the State has been unable to accompany the national and global scientific and medical developments in RM. It also requires to focus more actively in the simplification and modernization of the terms of free and informed consent for patients (TCLE) via the ethic evaluation system of the Commission for Ethics in Research (CONEP) - the central headquarter- and the Committees of Ethics in Research (CEPs) – distributed within institutions of education and research throughout the country. It is

evident, for example, that the instruments of TCLE must be better structured and targeted to the needs and levels of comprehension of patients, as well as, to the specificities of RM.

On the other hand, the State could have greater participation in a more transparent disclosure of information on ongoing therapies and clinical results through an adequate access to mass communication tools and services. The role of RM relevant agencies vis-à-vis the media is very limited, in spite of the national efforts taken towards defining a Programme on the Popularization of Science and Technology supported by specific grant calls, fellowships and scholarships and launched by CNPq and the Coordination for the Upgrading of Higher-Level Personnel (CAPES) (See, Tait Lima et al., 2018). Communication with the media has been taken up by specialized professionals and patient organizations committed to the local development of RM.

In summary, some of the advantages and disadvantages of the Brazilian State system in relation to practices in RM have been briefly discussed. The next section presents general conclusions and some recommendations for the future of the sector, at the national level, and its potential projection towards the global arena. They are based on our research results, as well as, on the comments from colleagues and research participants, that were generous enough to review a first draft of the present proposal.

## CONCLUSIONS

The study's results provided some indication towards the implementation and follow up of RM, engaging the wider public at the national level and tried to consider the near future projection of local RM at the global level. Conclusions are intended to contribute to orient, decision making processes at the most relevant State agencies, based upon recent evidence, and most especially, offer reflections on how to promote wider access to AT therapies for patients and their families.

For Brazil to become a global multiplier in RM, at least within Latin America, or else, a key actor among the so-called BRICS (Brazil, Russia, India, China and South Africa) and future BRICS 'enlarged', the sector has to be explicitly declared by the State to be a strategic area for national scientific and public health development. Most especially, as it has been recognized, that RM will become the 'medicine of the future' and Brazil's contribution cannot lag from this global redefinition of the field.

There is a need for the revision and upgrading of the specificity of the local laws, regulation and norms on clinical trials, in order to standardize them: the development, implementation and follow up of the results of clinical trials, especially of those that are multicentric. This process entails also the design of specific mechanisms for the inclusion of national and foreign capital more systematically and of the expansion of international collaborations and partnerships, of great relevance for the growth of RM.

The gathering, processing and storage of the large amount of data (Big Data) generated during clinical trials and the adoption of AT, requires the development of a new technical and ethical normativity and of innovative ways to monitor and disclose highly sensitive private information in data platforms.

One of the biggest obstacles, at a national and global level, in the present phase of AT regards the reformulation of manufacturing and distribution processes to adapt them to the new medicine. The lack of specialized professionals in Brazil in several new professions, requires substantive new

capacity building and an enlargement of State´s training programmes targeted to specific audiences.

An aspect to be taken into account prior to the stages mentioned, is that all the new public policies are to be based on empirical evidence (quantitative and qualitative information), as well as, be sustained by a periodical evaluation of their impacts and results. Results should also be informed to the general public in a mandatory, transparent, periodic and stable manner and through different communicational channels, e.g., at the national, regional and community-level.

The promotion of wide public debates, to dialogue on the main ethical and technical dilemmas in RM, should initially form part of the State´s responsibilities. The instruments used in overall well-acknowledged systems of public engagement, ensure the inclusion of the perspectives and practices that represent different sectors of organized civil society and they ae not being applied in Brazil (See, for example, Irwin,2001; Irwin et al., 2012).

## ACKNOWLEDGEMENTS AND SPONSORING INFORMATION

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# Climate is Controlled by a New Substance - Artificial Evaporation

Oleg Khalidullin

10% of the world's river flow is spent by the inhabitants of the planet for their own needs http://zeleneet.com/skolko-ostalos-chistoj-vody-v-sovremennom-mire/18751/?unapproved=226315&moderation-hash=f6be09f52f0d2f75a7931459722ee584#comment-226315

This volume has been formed over the last century and continues to grow at an accelerating rate. The creation of water itself and life on Earth was carried out in their interaction with the atmosphere and the water cycle. The basis of the water cycle in nature is the biocenosis of water and biota. A complex process developed, consisting of precipitation formation, the movement of clouds, the concentration of their volumes, determining the places of precipitation, the movement of water through the soil, the dissolution of soil organic matter and minerals, and the supply of these substances to the roots of plants and animals. Vapors rise from the oceans and other bodies of water. No less, if not more, amount of evaporation goes into the atmosphere from vegetation and living beings (biota). Evaporation from the biota has its own bouquet, unique for each locality, of many individual waste products of respiration and excretions, which form their own conditions for precipitation in the clouds. Over millions of years of interaction between biota and the atmosphere, a special mechanism has been developed that has created a variety of arid zones in terms of precipitation, weather conditions, and diversity of ecosystems. Not only does biota depend on atmospheric conditions, but the atmosphere also depends on biota. It is quite possible that the properties of clouds depend on the quality of the molecules that are lifted up by evaporation. Water has not yet been studied by man and contains many secrets. Especially in its gaseous state. One of them is the processes of sedimentation and distribution of precipitation.

The substance, new to nature, of a significant part of the evaporation from the land is homogeneous in its structure and properties, returns to the atmosphere without fulfilling its natural functions on the soil. It does not change in the soil, does not dissolve the organic matter and chemicals of the soil, is not transformed in the roots and leaves of plants and tissues of living organisms. Evaporation without this main link in the water cycle can be called artificial. Produced from all areas taken from nature - arable land, deforestation, areas of garbage and ore landfills, man-made reservoirs and canals, sewage lagoons, asphalt and other objects that have blocked the flow of water to natural ecosystems.

Anatoly Wasserman claims that water vapor in the atmosphere absorbs infrared rays more than carbon dioxide by orders of magnitude. - https://yandex.kz/video/preview/?filmId=16091140096403881038&text=«Кто%20стоит%20за%20Гретой%20Тунберг»%20Виктор%20Савин&path=wizard&parent-reqid=1591855999491604-487002153313998345000419-prestable-app-host-sas-web-yp-132&redircnt=1591856016.1

The water cycle with artificial evaporation of previously unprecedented volumes does not fit into the natural biocenosis. The volumes and speed of evaporation have changed - water evaporates

from asphalt and arable land much faster than from forest or steppe cover. The frequency and geography of precipitation has also changed - in some places, the lack of precipitation with droughts and fires in others - an excess with floods. There are reports of rain and snowfall in the deserts, which have a negative impact on local wildlife. But an even greater danger in the short term is a decrease in precipitation on mountain and polar glaciers - they disappear.

https://interesnosti.com/1974565708840831757/samye-vysokie-gory-na-6-kontinentah/:

The snow cap that has covered the top of the mountain for 11,000 years since the last Ice Age is melting fast. Over the past 100 years, the volume of snow and ice has decreased by more than 80%. It is believed that this is not caused by a change in temperature, but by a reduction in the amount of snowfall.

The melting of mountain glaciers leads to the dehydration of numerous continental zones and the disappearance of fresh water rivers.

https://hi--news-ru.turbopages.org/s/hi-news.ru/research-development/k-2050-godu-polovina-naseleniya-zemli-mozhet-ostatsya-bez-presnoj-vody.html: By 2050, between 3.5 and 4.4 billion people in the world will be limited in access to clean fresh water, and more than 1 billion of this number are residents of large cities. Among the 482 cities and towns that were included in the study, more than a quarter will face the problem of a lack of fresh water to meet all needs in the future.

The lack of precipitation in the mountains and at the poles of the planet means a decrease in long-term accumulations of snow, and may lead to the complete disappearance of rivers.

Depriving water of its main functions leads to reciprocal resistance. It is expressed by natural disasters, but we do not understand this and continue to exploit it with increasing acceleration. We load it with various works more and more. Her responses are amplified in power and frequency. Strategically, water in the defense of its rights begins to destroy what interferes with its nature - man. This confrontation leads the planet to its original state of separate islands of a dry, lifeless firmament surrounded by salt. m ocean.

Neither water nor biota need this, even more so for ourselves.

Salvation is possible if we have time to free water from slavery - to return natural and reduce artificial evaporation.

It's not that difficult.

What does a person use so much water for? According to the information: http://vitality.moscow/kak-chelovechestvo-rashoduet-vodu/. In the world, 70% of water resources are used for agricultural irrigation and only 10% for domestic purposes. The remaining 20% obviously goes to production. All these waters are excommunicated from the wild, and after using a small part of it, it goes into the atmosphere without change. Man, as one of the subjects of nature, can consume water only for drinking. We, without thinking about the essence of water, have made it a means of production and comfort. They forced her to turn turbines, flood fields and reservoirs, wash herself and all objects around her, have fun with fountains and water parks,

carry her feces. By dressing the rivers in concrete and stone banks of canals and reservoirs, we deprived the possibility of water contact with soil and minerals, and destroyed the link of water transformation into a solution necessary for biota. Biota is disappearing, and water has lost its job, its essence.

Considering the production of the most common product - rice, one can notice that its cultivation is one of the most wasteful types of traditional farming - it is irrigation, when the field is flooded with water, turning it into a pool:
http://www.upcscavenger.com/WikiMedia/stgeorgecottonirrig-1122288835/#page=media

Here the root of the plant we need consumes an insignificant fraction of this volume, the main part of the water evaporates and goes underground.

Scientists in some countries, in particular Israel and Ukraine, have found the possibility of growing plant products and rice, with minimal water consumption. Drip irrigation is used, in which each drop is applied only to a given root.

Here, much less water is used for evaporation. Although such fields have destroyed natural ecosystems, water consumption is no longer so wasteful. And on the scale of the world's rice field, this method will take a big step in reducing artificial evaporation.

Considering, in this way, each type of water consumption by human activity in interaction with biosystems, it is probably possible to stop the catastrophe.

For example, ore deposits are harmful to nature not only because they convert fuel into carbon dioxide, but also because in all disfigured areas the natural evaporation of the falling moisture turns into artificial. https://theconversation.com/cop24-in-coal-country-why-poland-is-europes-climate-denial-capital-103573

It is still possible to save life on the planet. Not with appeals and wishes, but fundamentally, at the state levels, to rebuild our attitude to water, reduce our water needs, make this a strategy for every country, every person. Nature urgently needs to return its natural water cycle process.

All actions, works, movements on green technologies, reduction of carbon dioxide emissions, alternative energy, biodiversity conservation, protection and restoration of nature - all this is combined into a single direction - the restoration of natural ecosystems and the reduction of artificial fumes.

Some of these possibilities can be applied everywhere, if we use the experience of developed countries, implement many inventions to reduce artificial evaporation, and reduce water consumption. It is known that in the Scandinavian countries and Japan there are no more landfills; in Israel, plant products are grown with minimal water consumption. In many cities, houses with vertical and roof gardening are being built.

Here there are unlimited opportunities for growing plant products, and, with a normal organization on a city scale, this will reduce the need for expansion of agricultural areas.

There are inventions that make it possible to generate electricity without reservoirs in rivers.

There are ways to save water on airplanes with water reuse. The principle is applicable to homes and businesses. The following information can serve as an example of saving water in everyday life: https://aquabalt.ru/blog/skolko-nuzhno-chelovechestvu-vody: In Tel Aviv, this is in Israel, it is 140 l / day, of which 90 liters of waste water are treated and supplied for irrigation.

A new technology has been developed for deepening the bottom of rivers by using the movement of water, with minimal energy consumption, without polluting coastal areas and protecting them from floods. All such measures should be developed and applied in the use of water in all technologies of all cities and countries. Only returning to nature its millions of years old water cycle can reduce natural disasters and stop climate change. It is necessary to carry out such tasks by the whole world, by every enterprise, by every country, by every person.

Read more at https://juniperpublishers.com/jojwb/JOJWB.MS.ID.555551.php

# Machine Learning Credit Card Fraud Detection System

Juliet Chinazo Onyema, Chidi Ukamaka Betrand, and Mercy Benson-Emenike

**Abstract:**

The Credit Card Fraud Detection system is a web-based fraud detector tool that can be used to flag potential fraud cases in daily transactions. It is vital that credit card companies are able to spot fraudulent transactions using the credit card so that customers are not charged for items that they did not purchase. This article illustrates the modeling of a data set using past credit card transactions with the data of the ones that turned out to be fraudulent which is achieved using machine learning. The model recognizes whether a new transaction is fraudulent or not by validating a user before any transaction is being made through sending a One-Time-Password (OTP) to the user, hence detects 90% to 100% of the fraudulent transactions thus minimizing financial crime. The Structured System and Design Methodology (SSADM) technique was employed in developing this system. In this process, we have focused on analyzing and pre-processing data sets as well as the deployment of multiple anomaly detection algorithm such as Isolation Forest algorithm and Local Outlier Factor algorithm. The model was built with Python and implemented in an e-commerce site which was built with HTML, CSS, JavaScript and its database as SQLite. After building and testing the system, it was discovered that in order for the system to be more accurate and precise, more transactional data need to be fed to the system.

*Keywords: Machine Learning, Credit Card, Detection, Fraud, Data Science, Algorithms.*

## INTRODUCTION

Recently, online transactions are on the increase due to high purchase of goods and services. In developed and developing countries, credit card is the most acceptable and common means of payment for online and offline transactions. It is discovered that some sensitive information about a credit card such as the credit card number, secure code, validity, Card Verification Value (CVV) number and name of card holder are often compromised so as carry out an illegal and fraudulent transactions which can lead to huge financial loss to both the issuing banks and to the individual owner [1].

Fraudulent Credit Card transaction is an illegal and unauthorized usage of one's account other than the rightful owner of the account. This article aims at reducing online credit card fraudulent activities drastically by implementing OTP code verification to validate every transaction as well as reporting fraudulent activities to the real card owners.

Another promising way of reducing successful credit card fraud is based on the analysis of existing purchase data of the cardholder [2]. Considering that humans tend to exhibit some specific behavioral profiles or patterns, card holders can as well be represented with a set of patterns containing information about the purchase details; the time, amount spent and so on. This helps to identify unusual patterns in fraudulent activity by combining real-time transactional data with the historical analysis of customer behavior which leads to complete auditing, transparency and traceability. However, deviation from such habitual patterns poses as a potential threat alert to the system.

Meanwhile, some loop-holes were discovered in the existing system, these include:
- No request of OTPs for subsequent online transactions once card details are saved online.
- Non confirmation of owner's details before making transactions.
- Non availability of 3D-security enabled in most cards.

In this article, the model used validates an individual before every transaction, analyzes the individual's spending pattern; how often the individual does online transactions (web, POS, Online) on a monthly basis, keeps record of every fraudulent credit card transaction, prevents card fraud as well as notifies an individual whenever there is a fraudulent attempt. This technique promises high predictive accuracy in fraud detection and prevention.

## BACKGROUND STUDY AND RELATED WORKS
### Overview of Credit Card
Credit Card is a thin rectangular piece of either metal or plastic issued by banks or financial institutions that allows cardholders to borrow funds with which to pay for goods and services with merchants that accept cards for payment [2]. On its front are the bank name, card number, card holder's name the chip and the expiry date then at its reverse are the magnetic strip, signature, hologram, and the Card Verification Code (CVC) as shown in Figure 1 below:
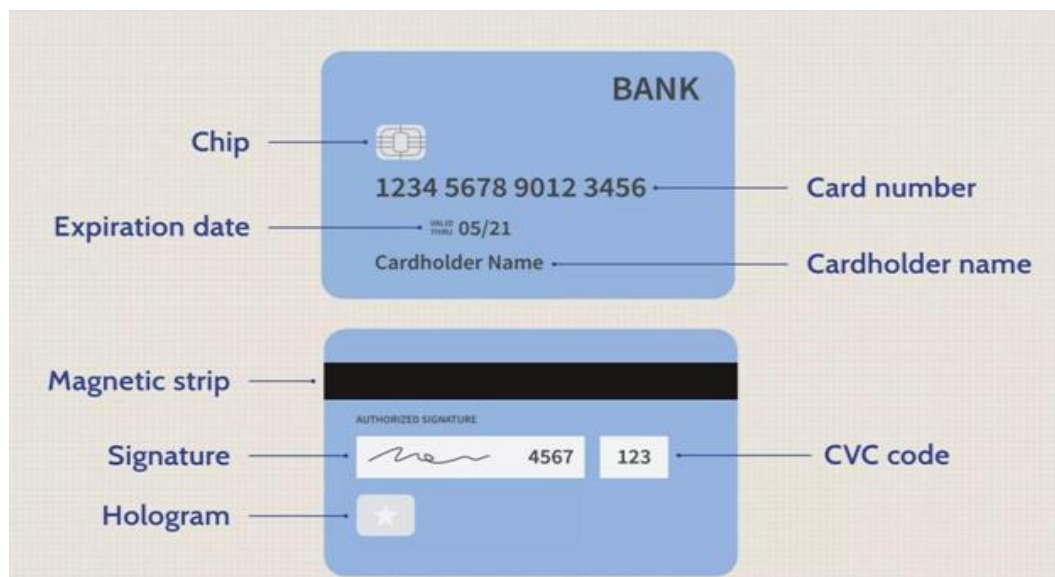


**Figure 1: Diagram of a Credit Card**

With credit cards, shopping online, reserving airline tickets and ordering from a catalog becomes a breeze. Mailing a cheque is almost a thing of the past as a credit card is faster, easier, and generally a more secure way of doing business. Sadly, it seems that fraudsters are keeping track and even thriving in this growing environment [3].
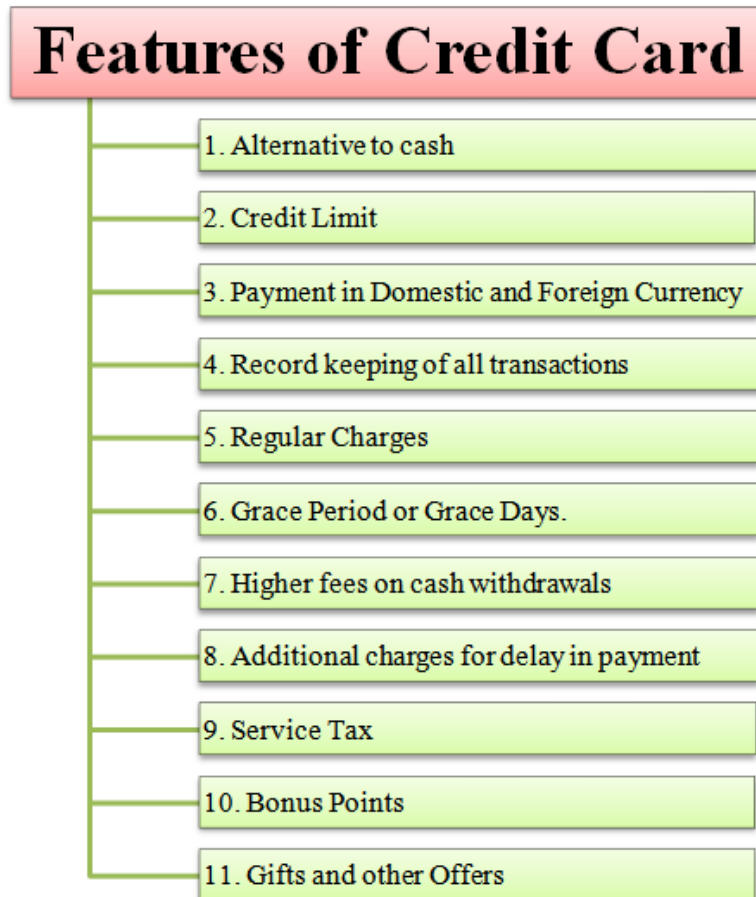
**Figure 2: Characteristics of Credit Card**

Though frauds can be online or offline [4], Credit card frauds are categorized in various ways but split into application frauds and behavioral frauds. In application frauds, the fraudsters apply for a credit card with a false ID whereas in behavioral frauds, the fraudsters find a way to obtain the cardholder's credential in other to use a pre-existing credit card. The fraudulent transactions are into six categories with respect to the fraudulent process:

1. Frauds from lost or stolen cards
2. Frauds from counterfeit cards
3. Online frauds
4. Bankruptcy frauds
5. Merchant frauds
6. Frauds from cards that got stolen during the expedition process.

However, an online fraud is committed through the internet, phone, shopping, web or in the absence of the card while an offline fraud is committed using a physical stolen credit card [4]. Tools have been developed to generate card numbers as shown in figure 3. These numbers are then used for "credit master attack", which consists in brute force attacking the merchant website with lots of possible cards [5].

**Figure 3: Card Number Generator**

## Related Works

Fraud detection in Credit cards has drawn great attention from the scientific community, though countermeasures have been proposed. According to the most recent learning research, Machine Learning (ML), Support Vector Machines (SVM), Bayesian Networks (BN), Artificial Neural Networks (ANN), K-Nearest Neighbor (KNN), Hidden Markov (HM), Fuzzy Logic Systems (FLS) and Decision Trees (DT) are some of the techniques that are often employed for fraud detections [6].

In their research, the Support Vector Machines (SVM), Decision Trees, Logistic Regression and K-Nearest Neighbor algorithms offer medium accuracy while the two methods with the lowest accuracy are Fuzzy Logic and Logistic Regression. The Neural Networks, Naive Bayes, Fuzzy Systems, and KNN are of high detection rate. Meanwhile, ANN and Nave Bayesian Networks are two algorithms that consistently outperform each other. The drawback of these algorithms is that they do not always give the same result across different contexts. They perform better with some datasets while performing worse with others. While raw, unprocessed data yields decent accuracy with techniques like fuzzy logic systems and logistic regression, small datasets yield outstanding results with algorithms like KNN and SVM.

Another study was based on the transactions and data mining techniques, it examined data mining approaches such as Bayesian networks, Bayes Minimum Risk, evolutionary algorithms, Hidden Markov Models (HMM), and ontologies with the aim of lowering credit card fraud. Next, it focused on improving the efficiency of the techniques used to detect fraud by improving the prediction of fraudulent accounts. As a result of their findings, it was possible to detect fraud more effectively by combining a learning strategy with a widely used technique [7].

A hybrid feature selection and genetic algorithm for e-banking fraud detection was also suggested [8]. The method was created using the reinforcement learning component of the neural network, however, Whale algorithm was also studied. The whale algorithm and the recommended approach were compared; hence the results demonstrated that the suggested technique was extremely effective in identifying e-banking fraud.

However, in 2016, another method was devised for detecting credit card fraud using unsupervised algorithms [9]. A model for detecting credit card fraud was released to meet the demands of computation simplicity and operation transparency. Two unsupervised techniques, Principal Component Analysis (PCA) and SIMPLEKMEANS, were developed to account for the geographical location of both transactions and clients. The recommended method, according to the authors, may detect fresh instances of fraud and directly and precisely identify the transactions. PCA offered a flexible and comprehensive picture of the connections between multiple features.

Navanshu *et al* described logistic regression, decision trees, random forests, and SVM in their research. They worked with a dataset that had a significant skew. The standards used to assess performance include sensitivity, specificity, accuracy and precision. The outcome showed that the accuracy of Logistic Regression is 97.7%, that of Decision Trees is 95.5%, that of Random Forest is 98.6%, and that of SVM classifier is 97.5%. They determined that the Random Forest algorithm is the most accurate algorithm out of all algorithms and is the best algorithm for detecting fraud. The data imbalance problem led them to the additional conclusion that the SVM algorithm does not perform any better in terms of detecting credit card fraud [10].

The difficulties associated with financial card fraud detection and associated mechanisms are also used to create a number of supervised algorithms. The authors classified the most important technique explored in Raj and Portia's analysis of numerous approaches. It also evaluates every methodology in light of particular design criteria. A few useful techniques for detecting credit card fraud were compared and evaluated in the study. It focused on methods for spotting credit card fraud, including Bayesian learning and Dempster Shafer Fusion. Any card-issuing bank must have a reliable system in place for identifying credit card fraud [11].

In the course of comparing Local Outlier Factor and Isolation Factor algorithms got an accuracy of 97% by the former and 76% accuracy by the later [12]. Credit card fraud was detected with various supervised machine learning algorithms with real-world datasets [9]. Ensemble learning techniques are dependent and independent variables in order to improve the accuracy of identifying credit card fraud. Various supervised learning-based techniques are compared and discussed.

Although we expect that if these algorithms are trained with more real-world data, the effectiveness and prediction will improve [13]. All the techniques showed minimal variance in performance. In conclusion, fraudulent transactions which constitute significant loss for both clients and financial institutions have been tackled with various approaches with subpar results. There is therefore, greater need to create improved fraud detection technique using deep learning implementation. This will give an improved technique in financial card detection.

## EXPERIMENTAL RESULT AND ANALYSIS

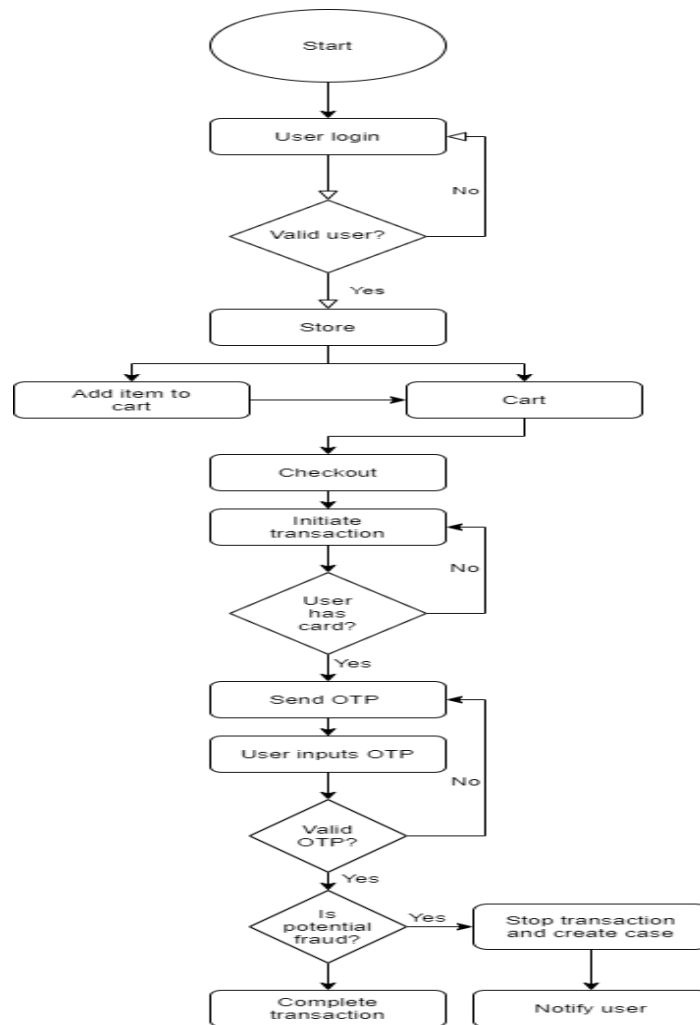The diagrammatic sequence of events is represented in Figure 4 below:

**Figure 4: Flowchart representing the workflow processes**

Authentication is first done by requesting and confirming the username and password after which the user initiates transactions with the credit card. The credit card about to be used is then validated by the system to ensure it belongs to the user before payment is approved. Payment validation is achieved by sending a secure code to the user to notify him of the pending transaction and the need to approve it by inputting the secure code. Lastly, a system check is done to prevent/detect any fraud attempt. In a case of no fraud, it completes the transaction otherwise it halts the transaction, creates a case and notifies the user. Figure 5 shows how data is fed through input devices such as the keyboard and is displayed on the monitor. Here, the input specification for the implementation of the fraud detection system used in an e-commerce site is shown below
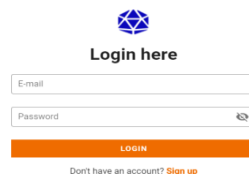


**Figure 5: User Login**

Figure 5 shows the user authentication process where the user is logged into the platform with a registered email address and password. The user email and password are then sent to the database to check for registered users with the exact credentials. If a matching user is found, the server returns the user's data along with a token for the user's logged in session. The user is then redirected to the home screen with lists of products as shown in figure 6
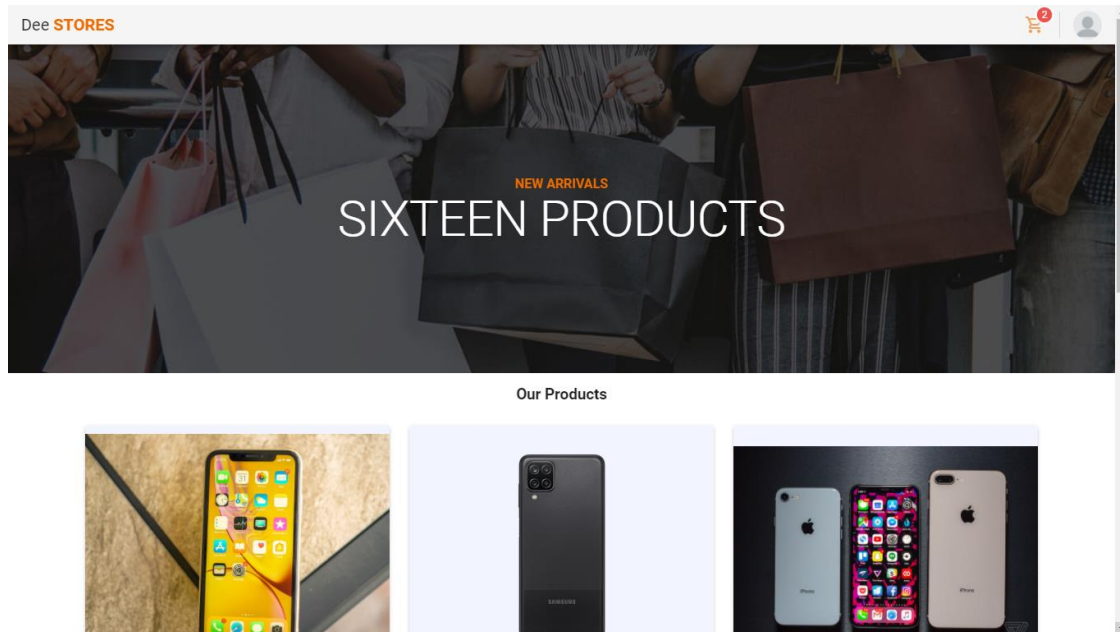


**Figure 6: Product's Home page**

Figure 6 shows the product's page where the user can easily add items to the cart with the click of a button. After all the selections have been made, the user then navigates to the cart page (Figure7) where the first stage of payment process begins.
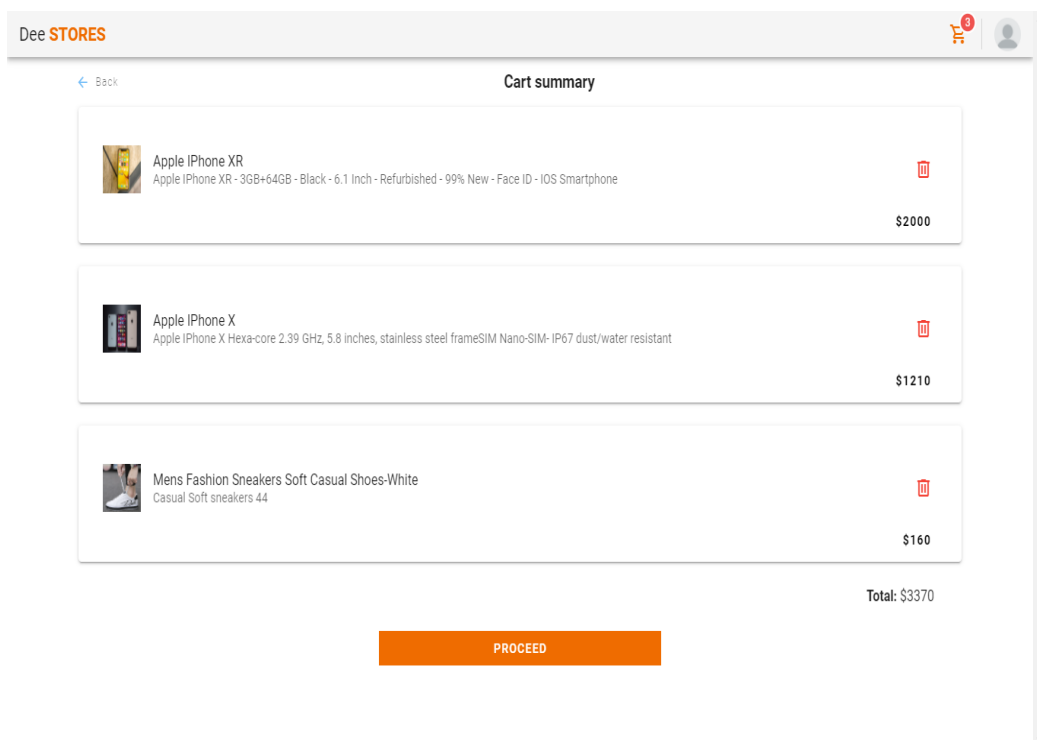


**Figure 7: Items in cart**

If the user decides to proceed to make a payment, the system will automatically send a secure OTP code to the user's email address as seen in Figure 8.
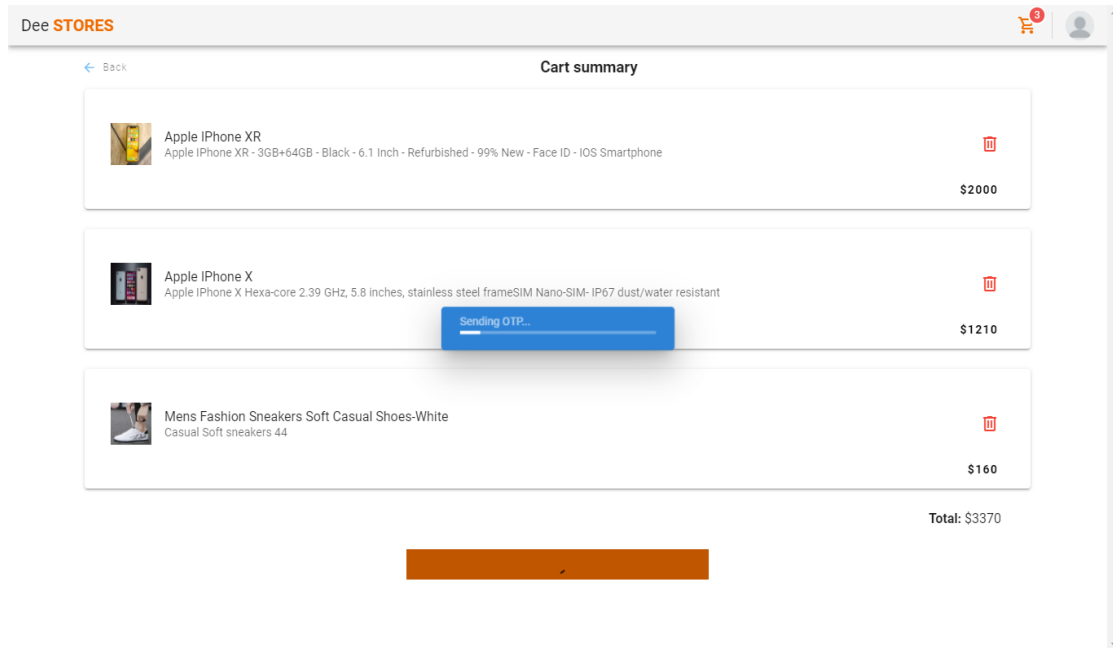


**Figure 8: Secure OTP code sent to user's email**

If a matching user is found, the server returns the user's data along with a token as shown in Figure 8 for the user's logged in session. The user is then redirected to the home screen with lists of products
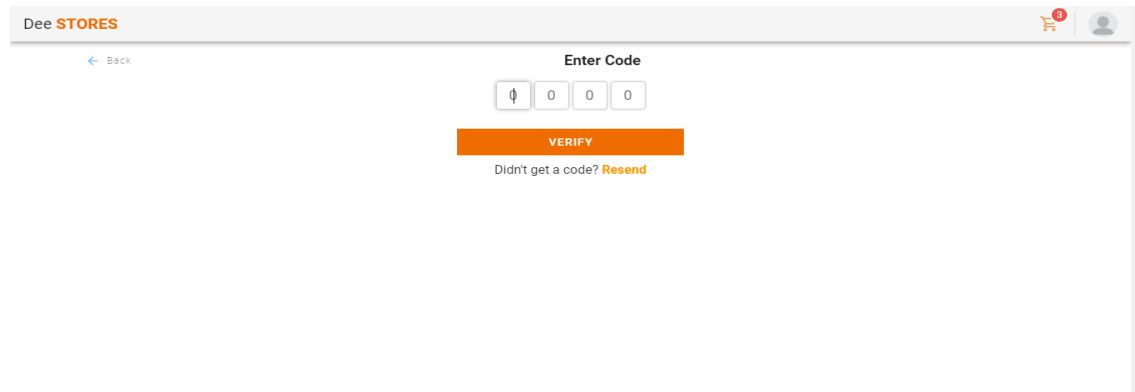


**Figure 9:User enters secure code**

Figure 9 shows the inputs provided by the system to the user for validating the OTP code sent. If the user enters the wrong code, the transaction process terminates. If the inputted code matches, the system then checks for a potential fraud case. Para venture, a case is found as in Figure 10, the transaction process is halted and a prompt email sent to the user.
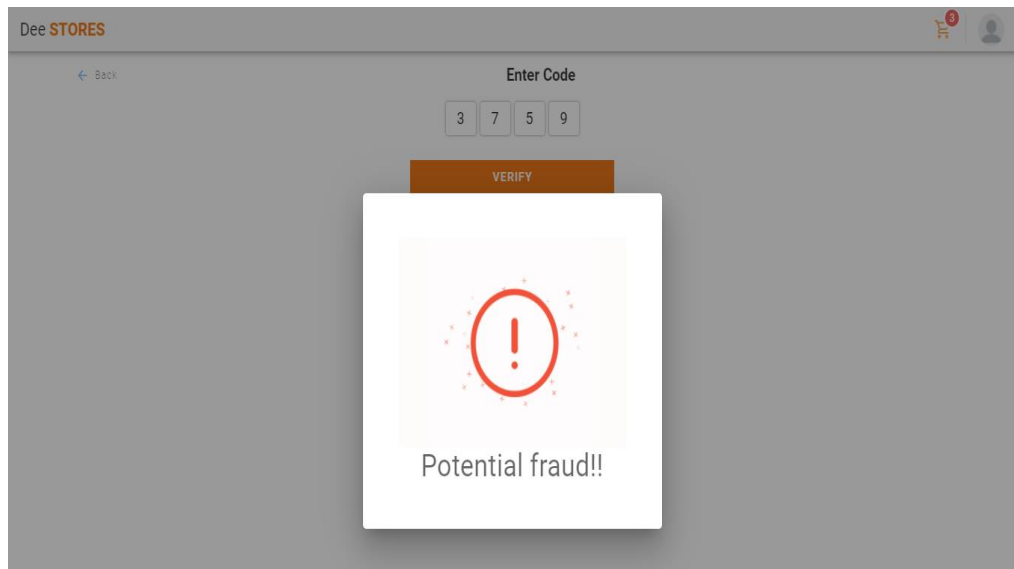
**Figure 10: System flags transaction as potential fraud**

## CONCLUSION

Recently, companies and individuals at large have been victims of online fraud. In this article, for the real-time detection of credit card fraud, a new approach was proposed for detecting online fraud according to research analysis and user requirements. The above enhanced model has shown a more promising result in the detection and prevention of credit card fraud as it recognizes when a transaction is fraudulent or not by employing multiple preventive fraud checks like User authentication, payment request validation (this confirms the user's authentication before transaction is initiated), payment confirmation(which further confirms the transaction by sending a secure code to the user notifying him of the pending transaction(s) and the need to approve it by inputting an already sent secure code), then finally, User System Check. The transaction is halted with a case created and sent to legal card owner notifying him of a fraudulent attempt. In a case of no fraud, the transaction process is completed. Hence, an improved and more secure transaction is ensured with reduced online transaction risks associated. However, this model can also be used in Banks, FinTech companies, Online Stores, Online Betting platforms and Mobile Wallets.

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# Evaluation of the Anti-Obesity Effect of Ethanolic Leaf Extract of Murraya Koenigii (Curry Leaf) on High Fat Diet Induced Obesity on Wistar Rat

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**Abstract:**

Obesity is a prevalent debilitating condition among individuals in both developed and developing nations. This investigation assessed the anti-obesity impact of ethanol extract of Murraya Koenigii (EEMC) on high fat diet obesity induced Wistar rats. Thirty (30) adults male Wistar rats with an average weight of 183g were divided into five experimental groups of six rats each Viz: Group A served as normal control and received standard animal feed. Group B was the control group and received high fat diet with no medications and treatment. Group C-D served as a treatment group administered with 200mg/kg and 400mg/kg of prepared EEMC respectively. While Group E received 150mg/kg of Xenical, which served as standard control. There was a statistically significant decrease ($P<0.05$) in the treatment and standard control groups (Groups C, D and E) and the decrease was in a dose-dependent manner. The total cholesterol (TC) increased in the normal and control group compared to other groups. There was a significant decrease ($P<0.05$) in the triglyceride (Tg) and low-density lipoprotein cholesterol (LDL-C) of all treatent groups. Their decrease was in a dose-dependent manner and there was a statistically significant decrease ($P<0.05$) between the groups compared to the normal and control. Moreover, the high-density lipoprotein cholesterol (HDL-C) had a significant inverse effect of the LDL-C as there was a significant increase ($P<0.05$) in HDL-C and the increase was more significant in the treatment groups (Groups C, D and E) respectively. The histopathology of the liver showed normal cellular architecture in the treatment group at the end of the experiment, thus posing no harmful effect. This investigation therefore suggests that EEMC has an anti-obesity property and elicited this through multiple mechanisms involving a decrease in body weight, body mass indices and alteration in lipid profile of obesity induced Wistar rats and could be used as a potential method of treating and managing patients with obesity disorder.

*Keywords: Xenical, obesity, hypercholesteremia*

# INTRODUCTION

Since the 1980s, the global prevalence of obesity, a complex condition, has more than doubled. Research indicates that the majority of the world's population resides in countries where the rate of overweight individuals exceeds the rate of underweight individuals, and this imbalance leads to more deaths. (Anderson and Butcher et al., 2003).

Obesity is diagnosed as an abnormal disorder characterized by excessive weight gain and numerous health risk factors. Given its increasing prevalence and its association with chronic health conditions such as heart disease, high blood pressure, diabetes, joint problems, gout, and high cholesterol, obesity has become a significant public health concern in both developed and developing nations. (World Health Organization, 2022).

According to an article published by the World Health Organization, complications related to overweight or obesity result in at least 4 million deaths annually. (World Health Organization, 2022). It has been reported that globally, obesity has nearly tripled since 1975, with over 1.9 billion adults being overweight and 650 million being obese. (WHO, 2022). International research on obesity has identified various competing structural explanations for the increase in body mass index (BMI), including globalization, economic development, and changing gender roles, all of which likely influence underlying behavioural mechanisms. However, previous research has not systematically tested these different explanations for the global rise in obesity. Previous studies estimate that if the current rate of obesity continues in the foreseeable future, there will be a projected 38% increase in overweight individuals and a 20% increase in obesity among the adult population. (Kelly et al., 2008). Another study conducted in the United States projects an 85% increase in obesity by the year 2030. (Wang et al., 2008). Standard drug treatments for obesity often come with adverse side effects and result in weight gain once the medication is discontinued. As a result, ongoing research aims to develop natural, safe, and effective remedies for obesity that minimize side effects while maximizing efficacy. Certain plant extracts and their bioactive compounds have been found to promote weight loss and prevent diet-induced obesity and related ailments. (Wang et al., 2008). Frequently, the plants and herbs used in cooking possess underlying medicinal benefits, and one of these benefits may include reducing obesity and its associated risk factors. One such plant rumoured to have these medicinal effects is the Curry leaf, scientifically known as *Murraya koenigii*. *Murraya Koenigii* (M. koenigii) is a tropical plant in the R*utaceae* family and is naturally found in Asia. Its foliage, commonly referred to as curry leaves, are utilized as a local seasoning in Indian, Asian, and African regions and is a widely used spice among Asians. The leaf of the *Murraya Koenigii* is recognized as a primary source of carbazole alkaloids, which are fragrant heterocyclic nitrogenous organic compounds that can be found in various medicinal plants abundant with cytotoxic, antiviral, and antibacterial properties. (Wang et al., 2008).

# MATERIALS AND METHODS

## Equipment Used for the Study

Rotary evaporator, (Model 349/2, Corning Ltd, England). Crestor high-speed milling machine, Whatman filter paper 1 (11µm), water bath (Chikpas Instrument, Enugu). Chemical balance (Gallenkamp, England), micro-pipettes (Perfect, USA), microscope slides, capillary tube. Handpicked leaves, Refrigerator (Haier thermocool, England).

**Plant Collection, Identification, and Authentication**

The Murraya Koenigii leaf was collected from University of Nsukka, Botanical Garden. The institution is in the Nsukka urban area, located in Enugu State, South-Eastern Nigeria. The plant was identified by Mr. A. Ozioko of the Bioresource Department and Conservation Program (BDCP), Research Centre Nsukka, and confirmed to belong to the Rutaceae family, Murraya genus, and Murraya Koenigii species with a herbarium number of University of Nigeria Herbarium (UNH) No. 66.

**Extraction of Ethanolic Extract of *Murraya Koenigi***

The collected leaves of *Murraya Koenigii* were dried to a constant weight at room temperature (29-35°C) for a period of one to two weeks. The dried leaves were pulverized into a coarse form with a Crestor high-speed milling machine (Chikpas Instrument, Enugu). The ethanol extraction of pulverized roots of *Murraya Koenigii* was carried out. One thousand grams (1000g) of the ground leaves of *Murraya Koenigii* were macerated in 1.5 liters of ethanol for 72 h, after which it was filtered with a mesh at 0.15 nm, followed by a Whatman filter paper. The filtrate was concentrated using a Rotary evaporator (Model 349/2, Corning Ltd, England) at a regulated temperature to separate the solvent from the extract.

**Preparation of Ethanolic Extract of *Murraya Koenigii* for Administration**

In previous investigation, it was discovered that the median deadly dosage (LD 50) of *Murraya Koenigii* for mice is 2500mg/kg/day (International Journal of PharmTech Research., n.d.). However, for the purpose of our trial, we utilized 8% (which is 200mg/day/kg) and 16% (400mg/day/kg).

**Experimental Animal**

Thirty (30) male Wistar rats (180 – 183g) obtained from the Animal House Unit of the Department of Zoology and Environmental Biology, University of Nigeria, Nsukka were utilized in the study. The animals were housed and acclimatized under standard conditions (25 ± 2°C) at 12h dark/light cycle. The rats were fed two times a day with high fat diet (Grand Cereals Ltd, Enugu Nigeria) and had access to clean drinking water *ad libitium*. The high fat diet contains 414.0 kcal/100g with 43% as carbohydrate, 17% as protein, and 40% as fat. The diet consists of a mixture of 68% normal rat chow pellet (Saintik Enterprise Malaysia), 20% instant milk powder (Dutch Lady), 6% corn oil (Krystal), and 6% ghee (Crispo). Normal rat diet contains 306.2 kcal/100g with 48.8% as carbohydrate, 21% as protein, and 3% as fat. (Levin and Dunn-Meynell, 2002) The high fat diet was given to the rats to induce obesity for duration of 6 weeks. Xenical was used as standard drug treatment in this study. The rats were acclimatized for duration of two weeks before the experiment commenced. The experimental animals were kept in 5 well-spaced cages with 6 rats per cage. The guide for the care and use of laboratory animals' procedures were followed in this study (Indian Council of Medical research, 2001).

**Experimental Design**

A total of thirty male Wistar rats weighing between 180 and 183 kg were divided into 5 experimental groups, each consisting of 6 rats. The groups were as follows:
- Group A = Control group
- Group B = High fat diet, no intervention (positive control)
- Group C = High fat diet + 200mg/kg of *Murraya Koenigii* leaf extract (administered orally)
- Group D = High fat diet + 400mg/kg *Murraya Koenigii* leaf extract (administered orally)

- Group E = High fat diet + 150mg/kg Xenical (standard medication) [administered orally]

## ETHICAL APPROVAL

Ethical clearance for this study was obtained from the Research Ethics Committee at the Directorate of Research and Publications, College of Medicine, University of Nigeria Enugu Campus.

## STATISTICAL ANALYSIS

All data were presented as mean ±standard deviation from the norm. The variations among treatment groups were examined by one-way analysis of variance (ANOVA) followed by Tukey post hoc examination for multiple comparisons using SPSS Version 21. P ≤0.05 were regarded as statistically significant.

## RESULTS

**Table 4.2.1. Effects of Murraya Koenigii extract on mean body weight of Wistar rats induced with obesity.**

| Groups | Pre-Obesity induction body weights | Obese weights (g) | Post treatment body weight | Percentage change in body weight |
|---|---|---|---|---|
| A | 185.00 ± 3.94 | 189.60 ± 3.05 | 194.40 ± 3.31 | 2.53 |
| B | 179.80 ± 8.50 | 477.20 ± 18.59* | 502.80 ± 8.71* | 5.36 |
| c | 185.80 ± 4.38 | 460.80 ± 41.76* | 254.00 ± 8.71* | -44.89 |
| D | 185.80 ± 7.09 | 474.40 ± 7.89* | 219.00 ± 8.80* | -53.84 |
| E | 181.00 ± 5.29 | 467.40 ± 15.99* | 265.40 ± 5.64* | -43.20 |
| **P-value** | **0.3809** | **5.8842e -15** | **P = 1.1102e -16** | |

Values were expressed as mean ±standard deviation: *P<0.05 showed a statistically significant difference compared to the normal control group. Also values with negative signs indicate that the parameters decreased. At the end of the experiment group B had the highest increase in body weight followed by Group A. Meanwhile Group C, D &amp; E decreased in their body weights. The decrease was highest in Group D. There was a statistically significant difference (P &lt; 0.05) between groups B, C, D and E on the obese weight and post treatment weight compared to the normal control group.

**Table 4.3.1: Effects of Murraya Koenigii on Body length of rats induced with obesity**

| Groups | Mean Initial body | Post obese body length | Post treatment body length | % Change in |
|---|---|---|---|---|
| A | 0.18 ± 0.004 | 0.186 ± 0.05 | 0.185 ± 0.003 | -0.54 |
| B | 0.178 ± 0.005 | 0.269 ± 0.007* | 0.282 ± 0.006* | 4.83 |
| C | 0.186 ± 0.006 | 0.277 ± 0.007 | 0.240 ± 0.008*β | -13.36 |
| D | 0.186 ± 0.006 | 0.277 ± 0.007 | 0.219 ± 0.006* βc | -20.9 |
| E | 0.182 ± 0.006 | 0.265 ± 0.006*cd | 0.241 ± 0.007* βd | -9.06 |
| P -VALUES | 0.0520 | P = 1.402e $^{-16}$ | P = 1.1102e -16 | |

Values were expressed as mean ± standard deviation: *P<0.05 showed a statistically significant difference compared to the normal control group. Also values with negative signs indicate that the parameters decreased. At the end of the experiment, Group B had the highest increase in body length. Meanwhile Group C, D and E decreased significantly in their body lengths, with
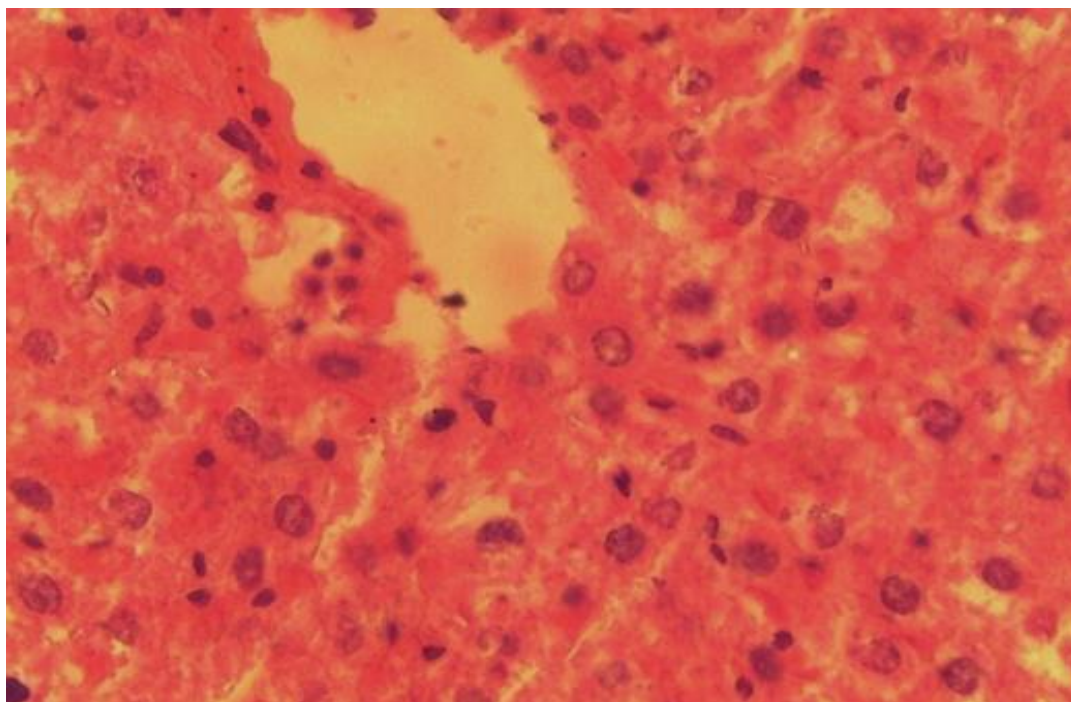
Group D having the highest decrease. There was a statistical difference ($p < 0.05$) between groups B, C, D, E on the obese weight compared to the normal control. There was also a statistical difference in Group E as compared to Group C and D. In the post treatment, there was a statistical difference ($p <; 0.05$) between groups B, C, D, E compared to the normal control. Still under post treatment there is also another statistical difference in Group C compared to Group B, in Group D compared to Group B and C, and finally in Group E compared to Groups B and D.

**Table 4.3.1: Effects of Murraya Koenigii on Body mass index of rats induced with obesity**

| Groups | Pre-induction ($kg/m^2$) | Post induction ($kg/m^2$) | Post treatment ($kg/m^2$) |
|---|---|---|---|
| A | 5.64 | 5.46 | 5.58 |
| B | 5.65 | 6.59 | 6.31 |
| C | 5.35 | 5.99 | 10.40 |
| D | 5.35 | 6.18 | 4.56 |
| E | 5.46 | 6.65 | 4.56 |

**Table 4.4.1: Effects of *Murraya Koenigii* on Total Cholesterol**

| Groups | Pre-obese | Obese | Post treatment | % Change in TC |
|---|---|---|---|---|
| A | 125.40±3.71 | 125.40±3.71 | 138.80±4.15 | 10.69 |
| B | 90.80±9.96* | 153.20±4.55* | 155.00±6.16* | 1.17 |
| C | 86.80±5.22* | 150.80±7.05* | 85.80±4.15$^\beta$ | -43.10 |
| D | 83.80±3.03* | 153.60±5.32* | 88.40±8.08$^\beta$ | -42.45 |
| E | 86.40±4.56* | 149.20±10.06* | 94.20±3.77$^\beta$ | -36.86 |



**Figure 1: Photomicrograph of section of the liver from experimental rats of groups 1. Showed the normal hepatic histology architecture and degeneration and necrosis of hepatocytes in (black arrows). Note the veinous/sinusoidal congestion in (black arrows). H and E x 400**

At the end of this experiment, group A had the highest increase in total cholesterol, followed by group B. Meanwhile group C, D & E decreased in their total cholesterol. The decrease was highest

in group E. There was a statistically significant difference ($P < 0.05$) between groups B, C, D and E on the obese weight compared to the normal control group. There was also a statistically significant difference ($P < 0.05$) between groups C, D and E on the post treatment compared to the positive control group
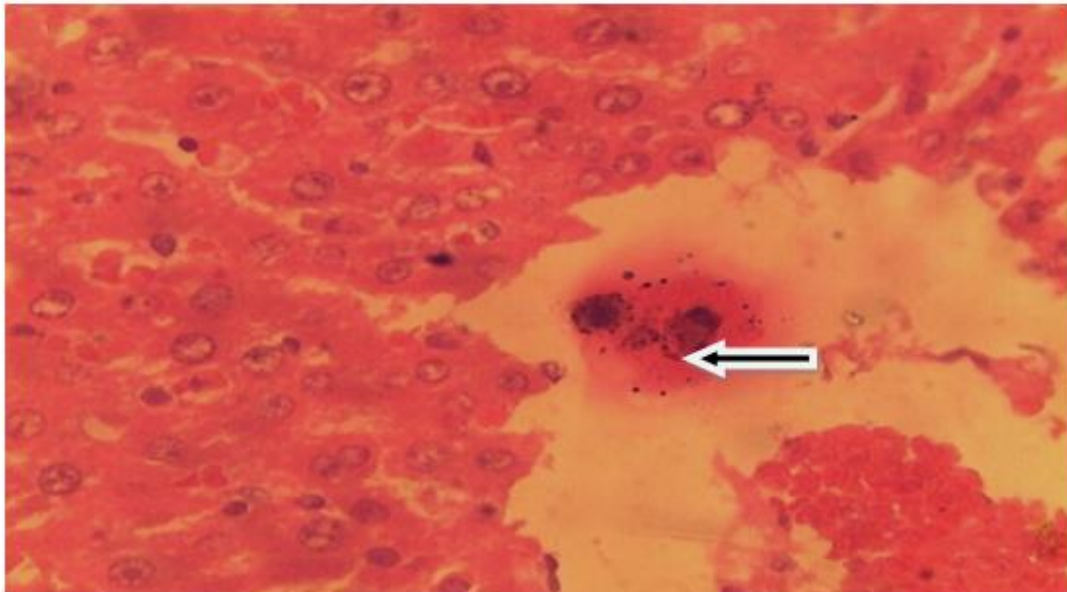


**Figure 2: Photomicrograph of sections of the liver from experimental rats of groups 2. Showed mild dilatation of sinusoids in (black arrows) degeneration and necrosis of hepatocytes with mild to moderate infiltration of inflammatory leucocytes (Arrow CV). Note the veinous/sinusoidal congestion in (black arrows). H and E x 400**
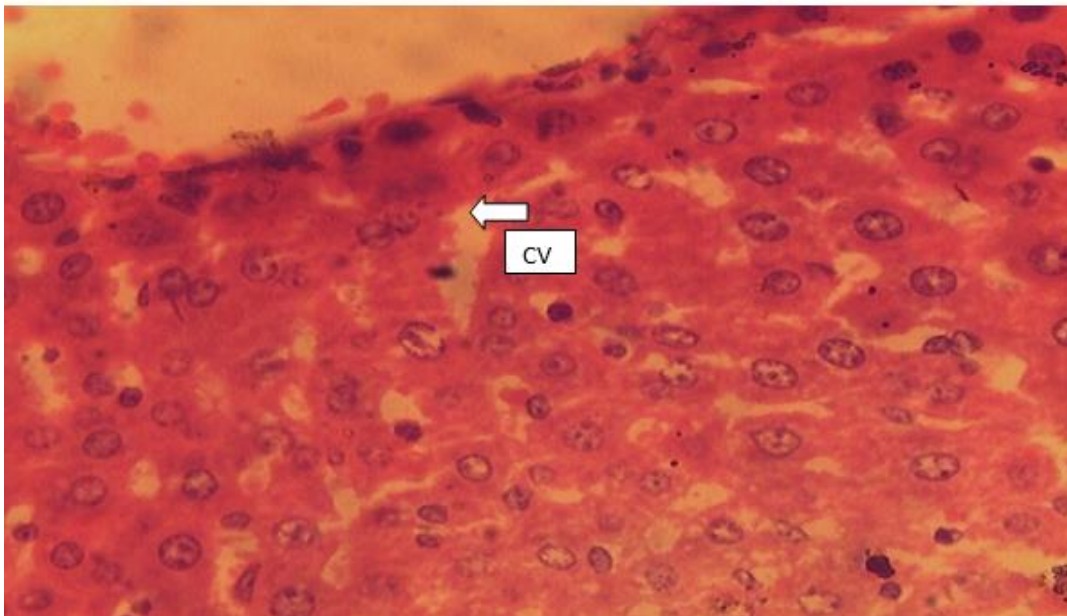


**Figure 3: Liver sections from groups 3 showing apparently normal hepatocytes distributed in a radial pattern away from the central veins with no significant change except mild congestion of the central veins (black arrows). H and E x 400**
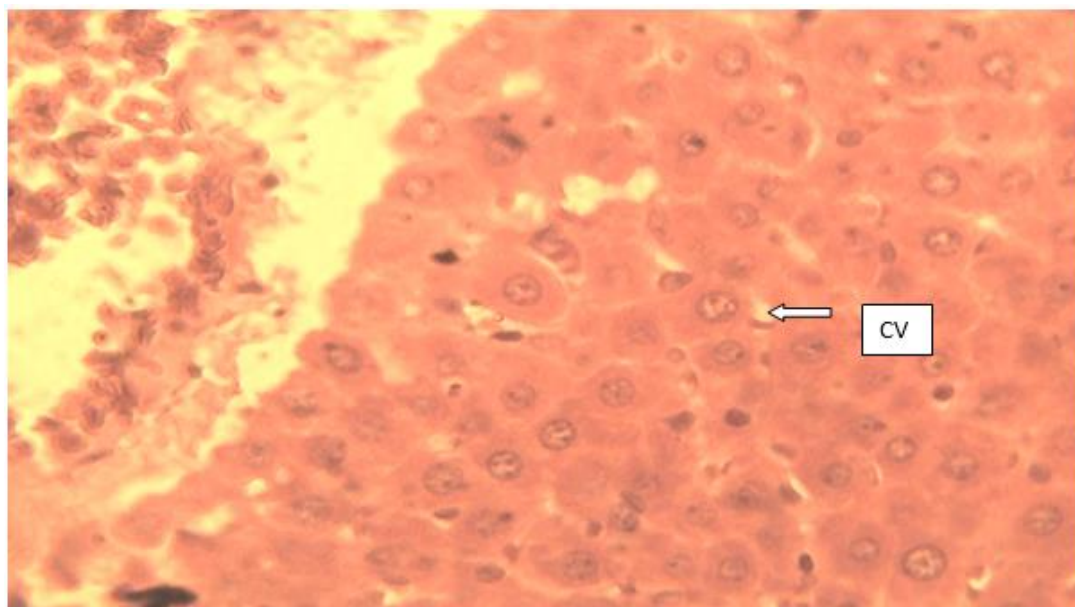
**Figure 4: Photomicrograph of sections of the liver from experimental rats of groups 4. Showed normal hepatocytes arranged in interconnecting cords around the central vein (CV). Note the dilatation of sinusoids in (black arrows) and degeneration and necrosis of hepatocytes. H and E x 400**

## DISCUSSION

This study aimed to assess the anti-obesity impact of the alcoholic extract of Murraya Koenigii on obesity induced by a high-fat diet in Wistar rats. The need for safer and more natural methods to combat obesity, as alternatives to manufactured drugs, is growing. In Nigeria, the use of Murraya Koenigii as a spice or herb for cooking purposes is not heavily regulated, and its potential as a medicinal herb has not yet been thoroughly explored. While food herbs are popular in Nigeria, little is known about the potential benefits and risks associated with isolated consumption. Currently, there is insufficient empirical data on the anti-obesity effects of Murraya Koenigii. This study aimed to evaluate the impact of oral and repeated administration of Murraya Koenigii on physiological parameters. In this study, oral administration of Murraya Koenigii had a significant effect on the average body weight of Wistar rats with induced obesity. There were significant changes in values across all groups compared to the control group. The treatment groups that received Murraya Koenigii (Groups C & D) experienced a significant reduction in body weight after four weeks of treatment. This is attributed to the presence of Mahanimbine, a major class of carbazole alkaloids, which primarily prevents hyperlipidemia and fat accumulation in adipose tissue (Jagtap et al., 2016). Treatment with 120mg of Xenical (Standard Drug) also resulted in a significant decrease in body weight at the end of the treatment period. This is because Xenical belongs to a group of medications known as lipase inhibitors, which work by preventing the absorption of dietary fat in the body rather than suppressing appetite (Consumer Medicine Information XENICAL ® Orlistat 120 mg capsules, n.d.). There were also notable significant changes in the body length and body mass index of the Wistar rats with induced obesity, with the experimental groups (Groups C & D) showing the highest percentage decrease in body length. The assessment of rat lipid profile revealed that oral administration of Murraya Koenigii significantly decreased the overall cholesterol in all treatment groups (Groups C & D) and this is possible due to the phytochemical properties of the Murraya Koenigii (Reshma, Prabhachandh and Babychan, 2017). The treatment groups were dose dependent and overall cholesterol (TC) significantly reduced in comparison to the control group. There was also a change

in values in the triglycerides (TAG) across groups, with a significant decrease in the treatment groups in comparison to the control groups orally exposed to the Murraya Koenigii. Conversely, there was a significant increase in the High-Density Lipoprotein (HDL) in the treatment groups in comparison to the control group while the alteration of values in the Low-Density Lipoprotein (LDL) showed significant reduction in comparison to the control groups whose effects were also dose-dependent. Previous research involving evaluation of the anti-obesity properties of the Murraya Koenigii in high fat diet induced rats shows a decrease in the overall cholesterol and triglycerides. In experimental research involving investigating the anti-obesity and anti-hypoglycemic, high fat diet induced Wistar rats had reduced Triglyceride, Cholesterol and Low Density Lipoprotein levels while conversely having elevated levels of High Density Lipoprotein (Tembhurne and Sakarkar, 2012) and findings from this study show the same result when compared to the control group.The lipid profile indices are useful in monitoring the health status of the cardiovascular system which are associated risks related to obesity. Elevated levels of TAG and LDL may predispose to cardiovascular related disorders like heart failure and coronary heart disease. Elevated levels of TC will likely lead to atherosclerosis. Previous study shows that extremely low levels of HDL are associated with a higher risk of death due to cardiovascular disease (MPH, 2016). Furthermore, in order to evaluate whether the oral and repeated exposure to Murraya Koenigii was capable of having an effect on the food and fluid intake of the Wistar rats during the treatment stage, close attention was paid to the rate at which the rats consumed the high fat diet. It was discovered that their rate of feeding, slowly reduced and was more prominent in the higher dose treatment groups. The light microscopic examinations of rat liver.

## CONCLUSION

The research findings revealed that there were significant alternative alterations in the body weight and body mass indices, lipid profile of rats induced with obesity and treated with the Murraya Koenigii in favor of combating obesity. Notable changes were observed in the body weight and lipid profile compared to the control group. Therefore, the Murraya Koenigii can be considered as a potentially beneficial herb in improving the rate at which the obesity disorder is addressed and managed.

## ACKNOWLEDGEMENT

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# Availability and Utilization of Agricultural Land Laboratories in Senior Secondary Schools in Makurdi Local Government Area, Benue State, Nigeria

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**Abstract:**
This study assessed the availability and utilization of agricultural land laboratories in senior secondary schools located in Makurdi Local Government Area of Benue State, Nigeria. A survey research design was employed to collect data from 363 senior secondary school students using a validated questionnaire. The objectives were to 1) determine the benefits of agricultural land laboratories, 2) examine the extent of their utilization, 3) assess their adequacy, and 4) identify challenges to their use. Results indicated several benefits including improved learning outcomes and skills development. However, challenges such as inadequate resources, lack of teacher expertise, and insufficient government support were inhibiting full realization of laboratory potentials. The study recommends strategies such as increased investment, improved availability and integration of laboratories in curriculum, as well as addressing resource challenges. These could enhance agricultural education and skills acquisition.

*Keywords: Agricultural education, Secondary schools, Land laboratories, Practical skills, Resource availability, Resource utilization, Infrastructure, Curriculum, Challenges, Nigeria*

## INTRODUCTION

In Nigeria, agriculture is a major sector of the economy, providing employment for about 70% of the population. The sector is being transformed by commercialization at the small, medium and large-scale enterprise level. In (1990), 82 million hectares out of Nigerian's total land area of about 91 million hectares were found to be arable. 42 percent of the cultivable area was farmed; much of this land was farmed under the bush fallow system whereby lands are left idle for a period of time to allow natural regeneration of soil fertility. 18 million hectares were classified as permanent pasture, but had the potential to support crops. It contributed about 32% to GDP in (2001) and the country's agricultural products fall into two main groups which are food crops produced for home consumption and exports. The youth which is the life-wire of every society are encouraged into farming through Young Farmers Club (YFC) and sometimes have their farms or gardens. They receive information and, in some cases, assist them in analyzing innovations towards agricultural development.

Agricultural Science is the branch of science which deals with growing of crops and rearing of domestic animals for the benefit of man and raw materials for the industries Ndem, (2013). He further explained that Agricultural Science deals with the production of crops and rearing of farm animals by man for the purpose of providing food, raw materials and shelter. It also involves the

science of processing, preservation, storage, marketing and distribution of the agricultural products. Mbanuju (2017) explained that Agricultural Science is the foundation of all sciences as far as sustenance of live is concerned. It provides food, raw materials, shelter, rural development, employment, foreign exchange to the nation and income to the farmers and his family.

Secondary education is a crucial tier in the hierarchy of education in Nigeria. It is the midway between primary and tertiary schools. It is the form of education that students receive after their primary education and or before their tertiary education. It is intended for pupils between the ages of 11-17. Secondary Education is the budding ground for future professionals as well as the foundation for the discovering and classification of the specific fields of professions. Prior to the independence of Nigeria through to (1982), Secondary Education lasted only five years. After the duration of five years, those who obtained the required qualifications were allowed for the two years of Higher School Certificate which qualifies them for university education.

A laboratory is a facility that provide controlled condition in which scientific or technology research, experiment may be performed. Laboratories used for scientific research take many forms because of the differing requirements of specialist in the various field of science and engineering Igbenewaka (2019).

Laboratory activities have long had a distinctive and central role in the science curriculum and science educators have suggested that many benefits accrue from engaging students in science laboratory activities. Inquiring in general and inquiring in the context of practical work in science education is central for candidate to show clear understanding of the problem in their working Hinetta (2017).

Availability of educational facilities refers to the provision made to the schools for effective teaching and learning. Provision of educational facilities should be among the very first preparation necessary for opening a new school. For instance, Uzoechina (2014) reported that the Ministry of Education among several other responsibilities usually carry out a resource visit to any new public or private school to ascertain the extent of availability of educational teaching facilities for its programmes. Consequently, proprietors of both public and private schools ought to ensure that provisions are made for these facilities as availability of such facilities as lecture halls, equipment like tractors, school farm, chemicals and fertilizer, experimental farm, personnel, storage facilities, pens among others are pre-requisite for approval of any secondary school in Nigeria. The non-availability of these facilities to teach the students are likely to lead to poor learning outcomes in Agricultural Science and also affects the teachers output thereby frustrating their efforts.

Utilization is the proportion of the available time (expressed usually as a percentage) that a piece of teaching facilities or instructional materials is being used. Hornby (2014) explained utilization as to make use of available resources at the individual's disposal. These resources include the facilities, equipment and experienced personnel. Olagunju and Abiona (2018) opined that the process of managing and organizing resources is resource utilization. They added that in a school, the available resources should be utilized in such a way that it enables the students to acquire desirable learning competencies. Utilization of resources in teaching brings about fruitful learning since it stimulates student's senses and motivates them and also gives correct representation to the abstract ideas, thereby making their meanings clearer.

In addition, lack of staff personnel to run the land laboratory was seen as the most serious problem facing the school farm. Closely followed by lack of updated equipment and machinery are inadequate state of the teaching facilities. Other problems include lack of agricultural inputs, lack of production of agricultural goods for internal consumption Francisco, and Radhakrisha, (2013).

**Statement of the Problem/Justification**

Agricultural Science is included in the senior secondary school curriculum in Nigeria in order to enhance vocational skills development, promote food security, and instill the right values related to agriculture. However, the research observes that Agricultural Science is not being properly taught in secondary schools in the study area of Makurdi Local Government Area, Benue state. This may be due to issues with the availability, adequacy, and utilization of essential facilities like land laboratories that enable practical, hands-on learning of Agricultural Science concepts and techniques. Land laboratories are particularly critical resources that allow students to apply their theoretical knowledge to real-world agricultural activities and demonstrate practical skills. Yet prior studies on the role of instructional facilities in teaching Agricultural Science in Nigeria have focused more narrowly without a holistic assessment of land laboratory conditions. This gap in understanding the current state of these vital agricultural education infrastructures motivates the need for this research. Specifically, assessing availability and how land laboratories are being utilized in secondary schools across Makurdi LGA can provide insight into whether these facilities are adequately supporting the objectives of the Agricultural Science curriculum. Addressing any shortcomings identified through this evaluation can then help strengthen practical training opportunities for students. Ultimately, this may lead to improved pedagogy and acquisition of skills that are essential for developing the local agricultural sector and ensuring food security.

## METHODS

A cross-sectional survey research design was employed to collect primary data using a self-administered questionnaire. This approach allows eliciting information on characteristics and relationships between variables concurrently (Creswell, 2012). The target population comprised all senior secondary students enrolled in the 22 registered public and private secondary schools located in Makurdi Local Government Area (LGA) of Benue State, Nigeria during the 2021/2022 academic session, totaling 7,592 students. The sample size was determined using Taro Yamane's formula for computing sample sizes from a finite population at a 5% error tolerance level (Yamane, 1967). This yielded a representative sample of 363 students. A multi-stage sampling technique was applied (Babbie, 2013). At the first stage, 11 schools were randomly selected from the sampling frame of the 22 schools using a table of random numbers. At the second stage, a systematic random sampling method was used to select 36 students each from the student registration lists obtained from the selected schools. This resulted in a total of 396 students included in the sample to allow for contingencies. The research instrument was a self-administered semi-structured questionnaire divided into four sections aligned with the study objectives. The sections addressed availability of land resources, frequency of land laboratory utilization, sufficiency of facilities and personnel, and challenges affecting utilization. A 4-point Likert scale ranging from Strongly Agree to Strongly Disagree was used for responses. The content validity of the instrument was established through expert review while face validity was ascertained via a pilot test. Reliability was determined using Cronbach's alpha coefficient obtaining an acceptable score of 0.85 (DeVellis, 2012). Collected data was analyzed using descriptive statistics involving frequencies, percentages, mean scores and standard deviations presented in tables and figures for objective interpretation.

## RESULTS AND DISCUSSION

### Table 1: Mean and Standard Deviation of the Benefits to the Use of Agricultural Land Laboratory in Secondary School in Makurdi Local Government

| S/N | Item | $\bar{x}$ | SD | Decision |
|-----|------|-----------|----|----------|
| 1. | Improved learning outcomes | 3.27 | 0.96 | Agreed |
| 2. | Enhanced practical skills development | 3.82 | 0.38 | Agreed |
| 3. | Experiential learning opportunities | 3.73 | 0.44 | Agreed |
| 4. | Reinforced theoretical concepts | 3.36 | 0.98 | Agreed |
| 5. | Increased engagement and interest in agriculture | 3.73 | 0.44 | Agreed |
| 6. | Promoted critical thinking and problem-solving abilities | 3.55 | 0.65 | Agreed |
| 7. | Hands-on experience with scientific equipment and techniques | 3.82 | 0.38 | Agreed |
| 8. | Enhanced understanding of agricultural processes and techniques | 3.73 | 0.61 | Agreed |
| | **Cluster Mean and Standard Deviation** | 3.55 | 0.46 | Agreed |

N = number of respondents, SD = Standard Deviation, $\bar{x}$ = mean of respondents

### Table 2: Mean and Standard Deviation of the Extent to Which Teachers Utilize Land Laboratory in Secondary Schools in Makurdi Local Government Area of Benue State, Nigeria

| S/N | Item | $\bar{x}$ | SD | Remark |
|-----|------|-----------|----|--------|
| 9. | Availability of land laboratory facilities | 3.27 | 0.86 | High Extend |
| 10. | Teacher training and competence in utilizing land laboratory | 3.55 | 0.65 | High Extend |
| 11. | Frequency of land laboratory utilization by teachers | 2.82 | 0.71 | High Extend |
| 12. | Integration of land laboratory activities into curriculum | 3.27 | 0.61 | High Extend |
| 13. | Adequacy of resources and materials in the land laboratory | 3.18 | 0.57 | High Extend |
| 14. | Support and encouragement from school administration for land laboratory use | 3.09 | 0.66 | High Extend |
| 15. | Collaboration among teachers in sharing land laboratory resources and activities | 3.36 | 0.64 | High Extend |
| 16. | Student engagement and participation in land laboratory activities | 3.27 | 0.96 | High Extend |
| | **Cluster Mean and Standard Deviation** | 3.22 | 0.71 | High Extend |

N = number of respondents, SD = Standard Deviation, $\bar{x}$ = mean of respondents

### Table 3: Mean and Standard Deviation of the Adequacy of Agricultural Land Laboratory in Secondary Schools in Makurdi Local Government Area of Benue State

| S/N | Item | $\bar{x}$ | SD | Remark |
|-----|------|-----------|----|--------|
| 17. | Appropriate storage facilities for harvested crops | 3.65 | 0.54 | Adequate |
| 18. | Well-maintained farming tools and machinery | 3.64 | 0.56 | Adequate |
| 19. | Adequate space for practical activities | 3.63 | 0.56 | Adequate |
| 20. | Availability of livestock for practical demonstrations | 3.61 | 0.59 | Adequate |
| 21. | Sufficient variety of agricultural crops | 3.59 | 0.59 | Adequate |
| 22. | Proper irrigation and drainage systems | 3.56 | 0.55 | Adequate |
| 23. | Access to quality seeds and fertilizers | 3.45 | 0.63 | Adequate |
| 24. | Availability of necessary equipment | 3.42 | 0.62 | Adequate |
| | **Cluster Mean and Standard Deviation** | 3.57 | 0.50 | Adequate |

N = number of respondents, SD = Standard Deviation, $\bar{x}$ = mean of respondents

### Table 4: Mean and Standard Deviation of the Challenges to the Use of Agricultural Land Laboratory in Secondary in Makurdi Local Government Area, Benue State

| S/N | Item | $\bar{x}$ | SD | Remark |
|-----|------|-----------|----|--------|

| 25. | Climate change and unpredictable weather patterns | 3.58 | 0.53 | Agreed |
|-----|---|---|---|---|
| 26. | Insufficient agricultural infrastructure | 3.52 | 0.61 | Agreed |
| 27. | Limited access to credit and financial resources | 3.50 | 0.54 | Agreed |
| 28. | Pest and disease outbreaks | 3.48 | 0.56 | Agreed |
| 29. | Inadequate access to irrigation facilities | 3.43 | 0.60 | Agreed |
| 30. | Limited availability of agricultural land | 3.41 | 0.64 | Agreed |
| 31. | Soil degradation and erosion | 3.38 | 0.63 | Agreed |
| 32. | Lack of proper land management and planning | 3.36 | 0.66 | Agreed |
| | **Cluster Mean and Standard Deviation** | 3.45 | 0.52 | Agreed |

N = number of respondents, SD = Standard Deviation, $\bar{x}$ = mean of respondents

## CONCLUSION

This study aimed to evaluate the status of agricultural land laboratories in Makurdi LGA secondary schools according to availability, utilization, sufficiency, and challenges. Findings revealed basic infrastructure existed widely but specialized facilities were lacking in many schools. Laboratory usage focused heavily on formal lessons with underutilization in other potential contexts. Facilities and materials scored moderately sufficient whereas instructors and technical staff sufficiency was lower. Major constraints centered around inadequate funding, infrastructure deficits, limited expertise, and poor integration.

Land laboratories demonstrated potential value; optimization is still needed. Comprehensive resourcing of specialized infrastructure tailored to curricular needs and local conditions is recommended. Strategic planning to diversify hands-on activities integrated across educational domains would maximize impact. Complementing physical capital with specialized human resources through focused training and incentives is equally important. Sustainable financing models along with public-private partnerships could alleviate budget constraints if properly implemented. Addressing integration flaws requires stakeholder commitment to align practical and theoretical instruction cohesively.

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# On the Application of the Concept of "Sustainability Resource of Complex Natural Systems to External Influences" in Some Applied Sciences

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The sustainability resource (SR) or resource of resistance to external influences is understood as the ability of natural or natural-technogenic objects and systems to withstand external influences and at the same time preserve and maintain their main functional properties within acceptable or specified limits.

For example, in relation to the geological environment: the stability resource of the soil mass at the base of the building will be determined mainly by the geotechnical characteristics of the soil, hydrogeological conditions, the load from the building, and the design features of the foundation. If the building maintains stability and other performance characteristics throughout its life span, then the SR of the geological environment at the site of its location is sufficient. If, under the influence of external factors (changes in GWL and subsequent subsidence of soils, karst-suffusion processes, seismic impacts, etc.), unacceptable structural violations or a significant deterioration in performance occurred, then the SR was insufficient, the designers evaluated it incorrectly, or preventive measures to increase it (for example, protective drainage, strengthening of the foundation, etc.) have not been implemented.

Our experience in using the SR indicator has shown its effectiveness for fairly complex and diverse natural systems, including taking into account anthropogenic changes. An assessment was made of the stability of the geological and hydrogeological conditions of the territory of the large city of Kharkiv (Ukraine) with an assessment of the risk of developing adverse processes (flooding, soil erosion, landslides) [1]. The SR assessment of the territories of several islands in the southern part of the Indian Ocean was carried out in terms of tsunami hazards, volcanic eruptions, seismicity, and global sea level rise [2]. A methodology has been proposed and tested for using this indicator for urbanized and industrial territories [3], and for large transport infrastructure facilities, in particular the metro [4, 5].

In view of the foregoing, having convinced ourselves of the fair universality of the SR indicator, we made an attempt to compare the main provisions (in terms of conceptual approaches to solving the tasks, methodology for solving them, and evaluating results) in such sciences as engineering geology (EG) and medicine (M). Such an unusual comparison appeared on the basis of the following.

The "man" system - the subject of research and practice of medicine and the "earth" system - the subject of research and practice of engineering geology (among applied scientific areas) are characterized by great complexity, openness, and variability under the influence of external influences and over time, a high level of uncertainty in terms of the timing and parameters of

changes, the widespread use of estimates based on related sciences (physics, chemistry, thermodynamics, biology, etc.). After such comparisons, there is a desire to evaluate the possibility of using medical experience that has a thousand-year history in engineering geology, the history of which is about a century.

Some methodological techniques are very similar or even coincide. For example, visual inspection and palpation (M); reconnaissance on the ground, and assessment of soil consistency by touch (EG) The study of information such as medical history, temperature, pressure, pulse rate, rhythm, etc. corresponds to the study of information about the engineering and geological conditions of the site, hydrogeology, geotechnical properties of soils. Of great importance is the genetic predisposition to certain diseases, reactions to external influences and pathogens (M); stability or instability of the territory to seismic, hydrological, and other negative factors (EG). Thus, we conclude that these and many other natural systems can be considered not only as a set united by the need for existence but also as a complex continuously interacting and changing structure, the stability of which was formed with the participation and under the influence of many factors.

In this regard, there is a natural desire to know what were the changes in the environment that did not exceed the limit values and led to modern man and his ability to adapt to adverse external influences and maintain his multifunctional capabilities. In the same direction, the sciences of the surface and underground spheres of the Earth, and the activity of EG processes are developing.

Computer modeling and predictive calculations help to solve practical problems, but so far, we see success only in predicting the possibility of events (changes), and great difficulties in terms of the time of occurrence and event parameters.

It is also important to note such a feature of the already named applied sciences as a large gap in time between the development of theoretical foundations and the corresponding practical achievements. In medicine, this can be attributed to diagnostics, and in engineering geology, to forecasting. The reasons here are the same and consist of deviations from direct dependencies due to numerous external factors. Moreover, if we evaluate the quality of the results according to significant criteria, then we will make sure that in medicine and engineering geology the reliability (in terms of probability and completeness) is quite high, and there are significant deviations in accuracy (time and parameters).

From these reflections, we can conclude that the methods of accelerated development and the introduction of non-standard approaches and methods of thinking are relevant to applied sciences.

This path can lead to the solutions that today we are trying to get through quantitative (not precise) estimates of possible events. Indeed, in almost all cases, we want to assess the risk of any system exiting an acceptable state. And this can be a unifying principle for the abstract representation of many applied sciences. Thus, traditional quantitative assessments acquire new meanings - ideas about risk (risk is weak, risk is significant, extreme situation). Further tactical actions based on this assessment will be actions to manage the states of a particular system in the future.

And now in the management process, trial and error methods are mainly used, which include the already accumulated base of theoretical knowledge and practical experience. Both in medicine

and in engineering geology and in many other applied sciences, means and methods are used to correct the state and functionality of an object (process), up to the replacement of essential details, for example, prosthetics, in some cases, and drainage or retaining walls in other cases. In this case, the main goal is to maintain the required functional potential of an object or system. This activity has signs of competition with nature. This not only complicates the task but also often makes it impossible for a given period of development of science and technology.

It is necessary to especially note such a common feature of applied sciences as spasmodic, i.e., the presence of periods of accumulation of theoretical and experimental potential, and then its implementation. In our reasoning, this can be depicted as an endless spasmodic development. With the help of such reasoning, we want to remind you that in reality, a multi-stage (let us emphasize this) development ends with a change in natural and man-made systems in people's lives, provoked by human activity (deforestation and an increase in the number of floods, the development of slopes and landslides, ocean pollution, etc.) or (and this is much worse) natural disasters (increased earthquakes, tsunamis, global climate change).

After such statements, the question arises: what is the way out? Our answer is there is a way! After all, for the sake of this, we touched on this extremely painful topic.

The way out, in our opinion, may seem unrealistic, since it affects the psychological problems and the basics of organizing the life of the majority of the world's population. That is, a certain level of education of the population and its unification with a common goal - survival is necessary. In other words, the preservation of our species is only on a conscious (scientific) basis. In this case, many objections may arise, since such an approach contradicts some well-established postulates. But we regard this as an unscientific attempt to explain the differences and difficulties in the problem of mutual understanding and, as a result, interaction.

Based on the foregoing, the following conclusions can be drawn:
1. Applied sciences have a number of general methodological principles, which makes it possible to act in search of common fundamental laws.
2. Comparison of the effectiveness of the methods of ancient and modern sciences makes it possible to advance in the study of the nature of the stability of various systems to external influences.
3. The position of transition from the widespread probabilistic approach in forecasting events, in a number of applied scientific areas, to cause-and-effect analysis and risk assessment on a scientific, rather than probabilistic basis, is being strengthened. It is understood that the probabilistic approach does not contribute to the development of scientific research, although it makes it possible to use retrospection.
4. The above theoretical conclusions contain an attempt to make more purposeful activity in solving general and specific life problems. At the same time, we hope that we managed to interest the reader and express the hope that our reasoning, based on our naturally limited life experience, will not arouse rejection from the reader.

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