FOREWORD

In welcoming our esteemed readers to Volume 8, Issue 1 of the Federal Polytechnic Ilaro – Journal of Pure and Applied Sciences (FEPI-JOPAS), I do so with immense pleasure. As we continue to uphold our tradition of publishing scholarly articles, we take pleasure in bringing you articles on issues of science, technology, health, and socio-economic development. The five articles that have been selected for publication in this volume clearly manifest the relevance, innovation, and rigour for which FEPI-JOPAS stands.

This highly scintillating edition begins with renown research findings from built environment by considering of the work of Eleshin et al. titled "Assessment of The State Security Actors' Response to Goods Smuggling in Yewa Region, Ogun State". Their study objectives are to identify categories of pronounced or popular goods smuggling; identify major routes for goods smuggling; and identifying major principal state security actors in charge of anti-goods smuggling. The Study also revealed that the Nigeria Customs Service (NCS)is the major and principal state security actor in charge of anti-goods smuggling activities in the study area. At the same time, Sango-Atan/Ota-Owode-Idiroko and Papalanto-Ilaro-Oja/Odan-Ohunbe axes were identified as the major/popular routes for the goods smuggling activities.

From the department of library science, Orelaja's research contribution was titled "Knowledge Management Practices a Predictor on Job Performance of Librarians in Selected Universities, Ibadan, Oyo State, Nigeria". Findings revealed a moderately high level of job performance among librarians (Mean = 3.21) and a similarly high level of KM practices (Mean = 3.30). The paper recommends that higher institutions invest in knowledge-sharing platforms such as digital repositories, online forums, and professional workshops to foster collaboration and enhance job performance.

Similarly, Okoh and co-workers tackle a pressing issue in their article titled "Molecular Identification and Antibiotic Susceptibility of Bacteria from Cow and Goat Meat in a Nigerian Market". Their findings suggest that meat sold in open markets harbors antibiotic-resistant bacteria due to poor hygiene and indiscriminate antibiotic use in livestock, they are therefore, advocating for improved sanitary measures, responsible antibiotic use, and regular microbial surveillance are

essential to safeguard public health. From the domain of crop production technology, Oyekale and Faremi. contributes to "Maize Response to Varying Weed Control Times: Growth, Yield, and Correlation Insights". This study examined maize response to varying weed control times in Nigeria's rainforest agro-ecological zone using a Randomized Complete Block Design with four treatments: Findings of their research confirm a critical weed control period within the first 4 WAP, essential for optimizing maize growth and yield

Finally, Ogunyemi and Alaba, deliver a crucial Nutrition and Dietetics study titled "Nutritional Qualities and Comparative Acceptability of Self Developed Flakes and Balls Produced from Oat and Cocoa Beans". It investigated the nutritional qualities and comparative acceptability of self-developed ready-to-eat flakes and balls produced from oat and cocoa beans. The study recommends that blending oat and cocoa in product development enhances both nutritional quality and consumer acceptability, food producers should prioritize using oat –cocoa composite flour in flakes and balls productions as they provide affordable, and acceptable alternatives to conventional breakfast cereals, with potential to promote healthier dietary choices.

Collectively, these efforts help to ensure that the journal continues to serve as a multidisciplinary forum for theory-and-practice bridging work. It is my pleasure to thank all authors for their dedication and scholarship, as well as our reviewers and editors for their tireless devotion to excellence. We invite our readers, academics, professionals, policymakers, and students alike, to explore the diverse insights offered in this issue. May these studies inform your work, inspire new ideas, and contribute meaningfully to scientific and societal advancement.

As we look toward future editions, we shall continue to uphold the highest standards of academic excellence, intellectual curiosity, and the relentless pursuit of knowledge. Thank you for your continued support for this Journal. I am looking forward to receiving your manuscripts for evaluation and subsequent publications. This journal is indexed in Arican Journal Oline (AJOL) and can be access online at https://www.ajol.info/index.php/fepijopas. You can also visit our website (https://fepi-jopas.federalpolyilaro.edu.ng/) for more information or contact us via e-mail at *fepi.jopas@federalpolyilaro.edu.ng*

Thank you and best regards.

Prof. Olayinka O. AJANI

Editor-in-Chief

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Assessment of The State Security Actors' Response To Goods Smuggling In Yewa Region, Ogun State

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ABSRACT

This study assesses the response of state security actors towards eradicating goods smuggling in Nigeria especially among the people of Yewa region of Ogun State. The study objectives are to identify categories of pronounced or popular goods smuggling; identify major routes for goods smuggling; and identifying major principal state security actors in charge of anti-goods smuggling. Relevant literature was reviewed, while secondary and primary data collection sources were equally used to obtain useful and relevant information for the study. Tables and simple discussion were used to present and analyse the collected data; it was discovered that about 90% to 94% youths between the ages of 18 to 53 are usually involved in the goods smuggling activities in the study area with about 66% rice and 20% frozen foods (Turkey and Chicken) identified as the major types of goods and services for smuggling. The Study also revealed that the Nigeria Customs Service (NCS)is the major and principal state security actor in charge of anti-goods smuggling activities in the study area. At the same time, Sango-Atan/Ota-Owode-Idiroko and Papalanto-Ilaro-Oja/Odan-Ohunbe axes were identified as the major/popular routes for the goods smuggling activities. Conclusively, the study recommended, among others, the creation of an enabling and suitable environment for the establishment of manufacturing industries for job opportunities for the youths as well as regular public enlightenment for community members on the anti-smuggling functions of state security actors.

Keywords: Actors, Goods Smuggling, Smuggling, State Security**.**

1.0 Introduction

Smuggling is an illegal, unlawful, and criminal act which involves the process of taking in or out, sending in or out as well as bringing in or out goods and services from one country to another secretly and illegally (Concise Oxford Dictionary, 2020). This act negates the provision of the law, hence punishable under the law, because it is a way of robbing a nation of its valuable economic growth and development, thereby reducing or shortchanging the expected total Gross Domestic Product that is supposed to be realized by a particular country in terms of Revenue generation.

Goods smuggling that tends to be regarded as illegal activities have turned out to be a usual and normal business and practices among majority of Nigerians especially the residents and people of border towns particularly in Yewa region of Ogun State because of their closeness to the border between Nigeria and the Republic of Benin. However, to eradicate this barbaric act, the Nigeria government have saddled the responsibilities and tasks with the state security actors whose major works is to ensure complete stoppage and eradication by bringing into book for legal punishment those involved in this illegal and unlawful activities.

However, the practice of cross-border trade activities has been a way of exchanging goods and services between 2 or more countries. The proceeds of these activities form an integral part of the economic growth and development of any nation. Each nation across the world adopts different modalities in ensuring a seamless and successful trade with its partners. The activities of this trade are controlled by some specific government agencies responsible for ensuring compliance with stipulated rules and regulations, simply referred to as state security actors that comprise both the military and para-military personnel. Meanwhile, in Nigeria, the Nigeria Customs Service

(NCS) is the major and principal state security actor among all these agencies and the NCS was positioned as the lead agency in the management of the seaports, airports and the nation's borders. The NCS is statutorily vested with the functions of revenue collection, facilitation of trade and suppression of smuggling. The suppression of smuggling becomes imperative due to the contravention of the rules and regulations associated with international or cross-border trade by the illicit practice (Mathias, 2018).

Legitimate cross-border trade activities are encouraged due to their prospects of developing the economy of the nation, unlike smuggling. Smuggling is a crime of taking, sending, or bringing goods secretly and illegally into or out of a country. The consequence of smuggling is very dangerous for any economy. It destroys the prospects of the economy and hinders the growth of infant industries that will industrialize the economy. It also poses a threat to national security with unlawful importation of dangerous weapons which could be subsequently used by criminal elements to destroy lives and properties of innocent people in society.

Smuggling is one of the major cross-border crimes that are a threat to the nation. The activities of smuggling are perpetrated by unscrupulous elements that prefer it to legitimate trade. In Yewa land and other areas in Ogun State, prohibited and controlled items such as Rice, Frozen foods, Premium Motor Spirit (PMS) and Cannabis Sativa, among others, are often smuggled across the border to various destinations. It is against this backdrop, that this study tries to assess the response of state security actors particularly the Nigeria Customs Service towards determining the sustainable means of reducing or eradicating smuggling to the barest minimum with less or no casualty to the host communities in Nigeria especially among the people of yewa region in Ogun State.

2.1 General Overview of Customs Services and Nigeria Customs Service.

The customs service plays a major role in the economic wellbeing of any given country. Equally, a significant aspect of the same is that it plays a key role in the sovereignty of a country. Customs is therefore entitled to the role of controlling whatever enters or exists a certain country. Coupled with that, customs play another major key role in the facilitation of trade. Nigeria National Petroleum Corporation (NNPC) is the primary internal income generator in the country, with Nigeria Customs coming in second. To have a substantial influence on national coverage, the agency recruited 5,000 Nigerians to the services in 2009.

To enhance the convenience of trade, Nigerian Customs has upgraded all of its processes in the crucial area of human resources and implemented cutting-edge information and scanning technology to improve the performance of the officers. The primary goal of monitoring is to prevent the importation of narcotics, guns and ammunition, hazardous blades, endangered animal and plant species and their products, the spread of animal and plant illnesses, the export of national cultural objects, and money laundering. Furthermore, customs enforce restrictions imposed on specific commodities to ensure that the goods are appropriately declared for tariff reasons. As a result, it is in charge of ensuring that different subsidies are paid on time. (Nigeria Customs 2017).

Nigeria Customs Service is headed by the Comptroller General who was assisted by (6) six Deputy-Comptroller General, heading different departments which include (i)Finance, Administration and Technical, (ii) Tariff and Trade (iii) Strategic Research and Policy (iv)Investigation and Inspection (v)Human Resource Development and (vi) Excise and Industrial Incentives.

The Comptroller-General of the Nigeria Customs Service is in charge of general administration and service direction. He is the service's accounting officer and vice chairman of the Nigeria Customs Service Board, which is chaired by the Honourable Minister of Finance of the Federal Republic of Nigeria (Nigeria Customs 2017).

Nigeria's customs role and goals in the twenty-first century are to prosper in a globalised and highly competitive society. The function of a gatekeeper in customs has not and will not become obsolete, as several trends indicate a greater and more complex role for Nigeria's customs agency. In the next years, the arduous process of integrating sophisticated international practices such as a single window allowing clients to interact with only one agency, and a well-coordinated border management focusing on border functions in a single organisation will be witnessed. More specifically, the authorised economic operator (AEO) regime uses track records and self-policing to allow customs to forego interventions against the clearly trustworthy or, at the very least, to limit intervention to a post-clearance audit. Intelligence-driven risk management concentrates efforts on cargoes and firms that must likely be noncompliant (Customs Modernization in Nigeria 2012).

It is difficult to forecast any institution's future role in trade facilitation because there is no single correct or universally applicable response to anticipated trends in customs, as each country will respond in ways best suited to its needs, operating environment, national priorities, and cultural heritage. (World Customs Journal 2008Considering the several functions that Nigeria Customs normally plays in the economy, one of the customs tasks has to do with revenue collection for the federal government. The performance of Nigeria Customs in 2017 was hailed as exceptional, with a total revenue collection of N1.10 trillion. To accomplish this milestone, the services used many steps, including strategic redeployment of officers and personnel, reforming and restricting of customs intelligence unit operatives, and a regime of timely rewards for hard performance and punishment for violators. Other methods include the possibility for automation, tracking, monitoring, and recovering lost revenues; Nigeria customs promote officers and men of the services solely on merit rather than linked forms; and purposeful stakeholder involvement throughout the country. Furthermore, the anti-smuggling crusade was a huge success, with the agency working tirelessly and recording over 4,000 assorted seizures worth over 11 billion naira. The seizures, according to NCS, include 2,671 pump-action rifles, dangerous drugs, foreign band rice, and smuggled vehicles, among other things. Even valiant officers are killed in the course of duty (Punch Newspaper 2017)

2.2 Mandate of the Ogun Area Command of the Nigeria Customs Service in Ogun State as regards Goods Smuggling

The Ogun Area Command of NCS is saddled with the responsibility of revenue collection, suppression of smuggling and facilitation of trade that is legitimate. For emphasis, the Command is essentially an Enforcement area vested, mainly, with the mandate of anti-smuggling operations in the whole of Ogun State, Nigeria, which borders the Republic of Benin. Under its statutory function of suppressing smuggling, the Command co-ordinates intensive round-the-clock anti-smuggling activities in its Area of Responsibility (AoR). This has resulted in huge seizures of smuggled goods, illicit drugs, and other psychoactive substances.
The activities of Customs operatives in Ogun State and in Yewa Region are regulated by law. For example, section 158 of Customs and Excise Management Act (CEMA) CAP C45 LFN of 2004 empowers Customs officers to patrol freely; sections 147 and 148, respectively, empower Customs officers to search premises and licensed premises; section 150 gives Customs officers power to search persons and section 8 gives Customs officers the power of police officers in respect of carrying out and enforcing provisions of Customs laws. This means that Customs can arrest, detain and prosecute persons who commit Customs-related offences. Section 167 empowers Customs officers to seize or detain goods suspected of being smuggled into the country.

2.3 Danger Inherent in Smuggling

There are numerous negative effects of smuggling activities. Prominent among them, as they affect or may affect the lives of the people of Yewa Region as well as Customs Operatives, including Loss of lives and properties, health implications, gross financial loss, and increased economic hardship.

2.3.1 Loss of Lives and Properties.

Loss of lives and properties is an imminent danger associated with Smuggling. Smuggling has a very great social cost in terms of death. Many valuable lives of smugglers, Customs operatives and other law enforcement agents and innocent community people have been lost to smuggling through gun exchange between smugglers and a team of law enforcement agents. Many properties of Customs and those of the communities have been lost to clashes in the past.

2.3.2 Health Implications.

Most consumable items are not good for consumption due to their mode of concealment during the process of smuggling to evade security check and arrest. For instance, the Ogun Area Command has on several occasions uncovered concealment of rice in vehicle petrol tanks and other compartments as well as fuel jerry cans. Sometimes some rice that are smuggled might have expired and must be repackaged by smugglers to be sold to unsuspecting members of the public.

2.3.3 Increased Economic Hardship.

Economic hardships increase with nefarious activities of smuggling. For instance, smuggling of PMS in jerry cans, out of the country, which ought to have been sold to people within the community would make it very scarce. The implication of this may warrant going far distance to buy it when in need, or

resort to getting black market of the PMS at higher rates. This may in turn hike prices of some items or consumables in the community. The buoyancy of smugglers because of huge financial gain from smuggling activities is another factor to consider. Their

3.0 Methodology

3.1 Sources of Data Collection

Both primary and secondary sources of data collection were used for this research with the aid of structured questionnaires as main research instruments.

3.2 Target Population

The target populations for the research are both the state security actors majorly Nigeria Customs Service and the residents of the selected border towns within the study area.

3.3 Sampling Techniques

Purposive, Stratified and Systematic sampling techniques were used for the study in the following proportions:

(i) Purposive sampling techniques for the selection of routes and towns for the goods smuggling activities in the study area which are Sango-Atan/Ota-Owode-Idiroko route or axis and Papalanto-Ilaro-Oja/Odan-Ohunbe route or axis while Idiroko and Ohunbe was equally chosen being the center base for the smuggling activities along these routes and axes.

(ii) Stratified sampling technique was used for the selection of interviewed state security actors along the selected routes based on their locations as they were found in different locations with similar responsibilities. the interviewed residents

(iii) Systematic sampling technique was used for of both Idiroko and Ohunbe Communities respectively.

3.4 Sample Frame and Size

Officials of Nigeria Custom Service and residents of the selected study areas were picked for the administration of designed questionnaire whereby 10 officers of custom services and 250 residents of the selected study areas were interviewed with 100 and 150 respondents from Ohunbe and Idiroko respectively.

3.5 Data Analysis

Collected data were presented and analyzed with the aid of frequency tables and a simple discussion for better understanding of the readers.

4.0 Results and Discussion

act of spending money may inflate the costs of goods and services, especially house rent. It will make standard of living high, competitive, and unaffordable to the common man.

4.1 State Security Actors' challenges towards effective response to goods smuggling.

Table 1 shows the hierarchy of different challenges facing the state security actors at effectively discharge their duties as reported by the selected respondent officers such as (i) inadequate manpower and logistics; (ii) misconception of the anti-smuggling function of customs by members of the community; (iii) hostility of members of the community; and (iv) insufficient or lack of required ammunition.

4.1.1 Inadequate Manpower and Logistics.

It was reported that the number of workforces in Ogun Area Command of Nigerian Custom Service is not commensurate with the vast border lines and several illegal routes in Ogun State. The available manpower is not adequate for police to haunt all nooks and crannies where goods smuggling activities take place. Inadequate logistics and absence of modern equipment are affecting the anti-smuggling activities of the Command.

4.1.2 Misconception of the Anti-smuggling function of Customs by Members of the Community.

The anti-smuggling mandate of the Command is often misconstrued by members of the community whereby it was believed that the anti-smuggling activities of Customs are deliberate act of depriving smugglers of their "lawful" means of livelihood. Smuggling is also perceived as the birth right of those in the border community that must be carried out unhindered. Therefore, any activities against such act are perceived to be acts of wickedness and thus the state security actors are regarded as enemies of the communities.

4.1.3 Hostility of Members of the Community.

The operatives of the Command have over time faced stiff opposition from members of the Community in the course of their duty. This is evidenced by many instances of connivance by the people of the community with smugglers carrying out

mob attacks on officers and blocking of access road to where smuggled goods were harboured. The effects of these have led to casualty on both side such as death or loss of government properties.

4.1.4 Insufficient or lack of required ammunition

The operatives of the command have always been facing the problem of insufficient or lack of required as well as upgraded sophisticated weapons and ammunition to fight with the smugglers who possessed more sophisticated weapons than the state security actors. This challenge has made them handicapped at times in discharging or carrying out their duties efficiently.

Table 1: Hierarchy of Challenges facing the state security actors as reported by selected officers (Nigerian Custom Services)

S/N	Types of Challenges in Hierarchy
1	Inadequate Manpower and Logistics.
2	Misconception of the Anti-smuggling function of Customs by Members of the Community.
3	Hostility of Members of the Community.
4	Insufficient or lack of required ammunition

Source: Field survey, 2023

4.2 Major/Popular Routes for Smuggling Activities

It was also revealed by the operatives of the command that the most popular routes for the smuggling activities in Yewa region are Sango-Atan-Owode-Idiroko and Papalanto-Ilaro-Oja/Odan-Ohunbe axes respectively, as indicated in Table 2.

Table 2: Major/Popular Routes for Smuggling Activities

S/N	Major/Popular Routes for Smuggling Activities
1	Sango-Atan-Owode-Idiroko axis
2	Papalanto-Ilaro-Oja/Odan-Ohunbe
3	Eegua-Igbogila-Aiyetoro axis
4	Ilara-Imeko-Afon axis

Source: Field survey, 2023.

4.3 Category of People Engaging in Goods Smuggling in the Study Areas

Table 3 shows categories of people involved in goods smuggling according to investigation from the study areas are basically the youths whose ages range between 18 years to 53 years which recorded about 92% and 94% of the entire population in the study areas respectively.

Table 3: Categories of Respondents

S/N	Age	Idiroko(F)	(%)	Ohunbe(F)	(%)
1	9-17	7	4.7	6	6
2	18-26	26	17.3	22	22
3	27-35	53	35.4	32	32
4	36-44	41	27.3	26	26
5	45-53	11	7.3	8	8
6	54-62	8	5.3	5	5
7	Above 62	4	2.7	1	1
	Total	**150**	**100**	**100**	**100**

Source: Field Survey, 2023

4.4 Major Types of Goods Smuggling

The most popular and major types of goods smuggling in the study areas were identified to be Rice which recorded for about 66%, followed by Frozen foods (Turkey & Chicken) with 20% with fairly used materials (such as clothes, shoes and leather bags), Petrol, Cannabis and Drugs which recorded for about 6%, 4%, 2% and 2% respectively as shown in Table 4.

Table 4: Major Types of Goods Smuggling

S/N	Types Goods	Idiroko(F)	(%)	Ohunbe(F)	(%)
1	Rice	99	66	66	66
2	Frozen Foods	30	20	20	20
3	Fairly used materials	9	6	6	6
4	Petrol	6	4	4	4
5	Cannabis	3	2	2	2
6	Drugs	3	2	2	2
	Total	**150**	**100**	**100**	**100**

Source: Field Survey, 2023.

4.5 Average Monthly Income Generated from the Activities

Study as indicated in Table 5 reveals that majority of the youths that involved in the smuggling activities usually generated between ₦90,000 and ₦300,000 monthly as income in rice and frozen foods smuggling which recorded highest percentage of about 84% compared to other goods that yielded between 8%(Fairly used materials), 5%(Petrol), 1.5%(Cannabis) and 1.5%(Drugs) respectively as a result of the popularity, acceptability and market values for the goods.

Table 5: Average Monthly Income Generated

S/N	Types of Goods	Average Monthly Income (₦)	Idiroko(F)	(%)	Ohunbe(F)	(%)
1	Drugs	10,000-30,000	2	1.5	1	1.5
2	Cannabis	30,001-50,000	2	1.5	1	1.5
3	Petrol	50,001-70,000	8	5	5	5
4	Fairly used materials	70,001-90,000	12	8	8	8
5	Frozen foods	90,001-110,000	21	14	14	14
6	Rice	110,001-300,000	105	70	70	70
	Total		**150**	**100**	**100**	**100**

Source: Field survey, 2023.

Summary of findings from the study include:

- Inadequate Manpower and Logistics.
- Misconception of the Anti-smuggling function of Customs by Members of the Community.
- Hostility of Members of the Community.
- Insufficient or lack of required ammunition.
- Popular Routes for the Smuggling Activities are Sango-Atan-Owode-Idiroko and Papalanto-Ilaro-Oja/Odan-Ohunbe axes respectively according to investigation.
- Category of People engaging in Goods Smuggling in the Study Areas are basically the youths whose ages ranges between 18 years to 53 years which recorded about 92% and 94% of the entire population in the study areas respectively.
- Average Monthly Income Generated from the Activities ranges between ₦90,000 and ₦300,000 while rice and frozen foods are identified as most popular goods smuggling

5.2 Conclusion and Recommendation

The Ogun Area Command of Nigeria Custom Service should be given a mandate of collecting revenue, facilitating legitimate trade, and suppressing smuggling in Yewa region and Ogun State in particular. The anti-smuggling activities of the Command are in conformity to the relevant sections of the CEMA Cap C45 LFN 2004. Smuggling is inimical to the socio-economic wellbeing of the people of Yewa region. It leads to loss of lives and properties, it has health implications, it inflicts gross financial loss to perpetrators and increases economic hardship to members of the community.

In line with the findings from the study, the following recommendations were made:

- **Provision of Adequate Manpower and Logistics**.

The workforce of the Command could be increased adequately to enhance their strength and performance. Provision of adequate logistics as well as modern equipment would also ensure effectiveness and efficiency of the Command's anti-smuggling operations. The NCS management is working assiduously to equip the Command with more manpower, logistics and advanced technology that would aid its activities and ensure safety of officers as well as those of the members of the host communities.

- **Consistent Enlightenment of Members of the Community on the Anti-smuggling Function of Customs.**

The members of the community need to be better informed and consistently enlightened on the mandate of Customs to carry out anti-smuggling activities. It is essential for them to understand that Customs do not make laws or formulate policies. It's only implementing or enforces the laws and fiscal policies formulated by the Federal Government of Nigeria (FGN). Therefore, Customs could not be perceived as enemies of the people of host communities.

- **Friendliness of Members of the Community**.

The Customs operatives need the support and cooperation of the residents of Yewa region for a better society. The efforts of Customs are to develop the economy and secure the nation's border lines. People need to desist from attacking officers and obstructing them on duty. Some of the Customs operatives are part of the community. They are fathers, mothers, uncles, aunties, sons, daughters, brothers, and sisters to members of the host communities.

- **Creation of an enabling and suitable environment for the establishment of manufacturing industries for job opportunities for the youths**

Nigeria government both at federal and state levels should as a matter of urgency and necessity create enabling and suitable environment in all ramifications that will encourage establishment of industries by both indigenous and foreign investors as a means of job creation and opportunities for the teeming youth population in the study areas.

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Knowledge Management Practices a Predictor on Job Performance of Librarians in Selected Universities, Ibadan, Oyo State, Nigeria

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ABSTRACT

Libraries and librarians play a vital role in higher education in providing essential information services for both academic communities and the broader society. Their contributions are fundamental to achieving institutional goals, and any deficiency in their performance could negatively affect the institution, students, and national development. This study examines the influence of Knowledge Management (KM) practices on the job performance of librarians in higher institutions. A survey research design was adopted, targeting 46 librarians in two universities in Ibadan, Oyo State, Nigeria—University of Ibadan and Lead City University. The total enumeration approach ensured that all library staff were included. Data was collected using a structured questionnaire and analyzed using descriptive statistics, correlation, and multiple regression analysis at a 0.05 significance level. Findings revealed a moderately high level of job performance among librarians (Mean = 3.21) and a similarly high level of KM practices (Mean = 3.30). Regression analysis indicated that KM practices significantly influence job performance ($\beta = .747$, $t = 5.797$, $p < 0.05$). The study concludes that librarians in these institutions demonstrate a moderately high level of job performance, supported by effective KM practices. It recommends that higher institutions invest in knowledge-sharing platforms such as digital repositories, online forums, and professional workshops to foster collaboration and enhance job performance.

Keywords: Job performance, Knowledge management, Librarians

1.0 Introduction

Performance is a multi-dimensional concept and attempts have been made by researchers to give an understanding to it. It refers to the accomplishment of a given task measured against pretest known standards of accuracy, completeness, cost, and speed. Performance is what an organisation hire employees to do and does it well. Performing employees help leaders to create excellent organizations; there is more commitment, satisfaction, and motivation for the overall job performance for the employee. Academic libraries in Nigerian universities have been making significant contributions to the mandate of their parent institutions, which are; teaching, research and community services geared towards social, political and economic development of the country (Sani, & Musa, 2019).

Little attention has been given to job performance of librarians in Nigerian universities and two major categories of job performance such as task performance and contextual performance have been identified (North, & Kumta,2018). Some of the problems of job performance are manifest in the form of decreased productivity, difficulty prioritizing tasks, committing errors in given tasks, or missing deadlines, turnover intentions among members of staff; among others. However, all these problems could make universities not to achieve their stated goals and objectives (Shahzad, & Khan, 2023). Effectiveness and efficiency refer to the ability of librarians to achieve an end goal with little to no waste, effort, or energy. Librarian effectiveness is intrinsically tied to the ability to support and enhance the academic mission of the institution. This encompasses a wide range of activities, from facilitating access to information resources to actively participating in the teaching and learning process. Effective librarians are those who can seamlessly integrate traditional library services with emerging technologies and pedagogical approaches, creating a dynamic and responsive learning environment (Echem, 2022).

Peer facilitation is the process of evaluating the performance of an entire team, not just as a librarian. Peer facilitation among librarians creates a supportive ecosystem where knowledge, skills, and experiences are freely shared. Unlike traditional hierarchical mentoring structures, peer relationships allow for a more egalitarian exchange of ideas, where each participant can simultaneously be both learner and teacher. This approach is particularly valuable in the rapidly evolving field of librarianship, where staying current with technological advancements and changing user needs is paramount. The process of

facilitating peer relationships often begins with structured programs implemented by library leadership which include peer mentoring initiatives, where librarians are paired based on complementary skills or experiences (Echem, 2022). In fulfilling the objective of effective and efficient job performance, some factors such as knowledge management practices.

Knowledge management practices refer to all the procedures that an organization do to create, choose, organize, utilize, and communicate knowledge as well as transfer significant data and experiences. The relationships that a person can adapt and apply will surely affect how well they grasp the data set (North, & Kumta,2018). Effective knowledge management practices can be a powerful catalyst for enhanced job performance. When librarians have ready access to the information and expertise they need, they can make more informed decisions, solve problems more efficiently, and innovate more effectively.

The measures of knowledge management practices are knowledge sharing and knowledge accessibility. Knowledge sharing refers to the exchange of information, skills, expertise, and insights among library staff. This practice encompasses a wide range of activities, from formal training sessions and mentorship programs to informal conversations and collaborative problem-solving (Abu-Mahfouz, et al., 2023).

The concept of performance encompasses both what has to be accomplished and how it can be realized. Job performance is considered the ultimate criterion in human resource management. Its assessment and analysis is capital for different organizational processes, such as personnel selection, compensation and rewards or training. Regardless of the purpose of the evaluation, organizations need accurate ratings of performance, and even better if they produce the same results while saving time and effort (Kaur, & Singla, 2019). “KM is the process of access to experience, knowledge, and expertise that produce new skills, enable work performance, encourage innovation and create customer value”. Typically, KM is knowledge process comprising knowledge creation, sharing, acquisition, transfer and application with infrastructures, skills and top management support that encourage and enhance KM processes. The existing literature on KM categorized the KM process into six parts: knowledge acquisition, knowledge sharing, knowledge creation, knowledge codification, knowledge application and knowledge retention. However, these types of knowledge processes are cyclically interrelated. Therefore, this paper proposes that KM processes can be divided into four individually distinguishable types, i.e., knowledge acquisition, knowledge sharing, knowledge creation, and knowledge retention (Alyoubi, *et al.*, 2018).

Empirically, conducted studies had found significant influence of knowledge management on organization employee’s performances. A study observed that knowledge creation, sharing, and application had significant positive effects on librarians' job performance in Nigerian university libraries. The research highlighted that knowledge sharing, in particular, was the strongest predictor of improved performance (Fagbola, & Ize, 2023). Another study investigated the relationship between knowledge management practices and job performance in academic libraries in South-Eastern Nigeria. Their findings revealed a strong positive correlation between knowledge acquisition, knowledge dissemination, and librarians' job performance (Anike, & Echedom, 2020). A study examined the impact of knowledge management on librarians' performance in federal university libraries in North-Eastern Nigeria. They found that knowledge creation and knowledge sharing significantly enhanced librarians' efficiency and effectiveness in service delivery

A study explored relationship between knowledge organization practices and job performance among librarians in academic libraries across the United States. The study revealed that effective knowledge organization positively influenced librarians' ability to support research activities, improve information retrieval efficiency, and enhance user experience (Lee et al., 2016). Another study investigated the impact of knowledge retention practices on job performance of librarians in corporate and law libraries in the U.S. Their research showed that librarians who effectively retained and utilized organizational knowledge performed better in areas such as competitive intelligence and legal research support (Vela, 2018). Virtually, many aspects of knowledge management have significant positive influence on job performance of employees and librarians as well. The implication of this is that library as an organization must ensure that knowledge management if fostered deliberately and productively.

Knowledge accessibility refers to the ease with which librarians can retrieve, comprehend, and utilize information necessary for their various responsibilities. This encompasses access to professional literature, best practices, institutional

policies, user data, and a wide array of other information resources that inform their daily work and long-term strategic decisions. One of the primary ways in which knowledge accessibility influences job performance is through its impact on decision-making processes (Abu-Mahfouz, *et al.,* 2023).

Preliminary investigations and the researcher's observations in some higher institutions indicates a decline in job performance of librarians in Nigerian academic libraries. This decline in performance may be linked to inadequate knowledge management practices. A dissatisfied librarian is unlikely to be productive, which can negatively impact institutional effectiveness. While numerous studies have examined job performance among employees, knowledge management practices as a potential factor influencing librarians' job performance is yet to be extensively explored. The study seeks to address the gap by investigating the role of knowledge management practices as determinants of librarians' job performance in universities, Ibadan, Oyo State, Nigeria, Nigeria.

Thus, the objectives of the study include: identification of the level of knowledge management practices of librarians in universities, Ibadan, Oyo State, Nigeria; and determining the influence of knowledge management on the level of job performance of librarians in universities, Ibadan, Oyo State, Nigeria. In view of this, this research aims to answer the following questions:

1. What is the level of knowledge management practices of librarians in universities in Ibadan, Oyo State, Nigeria?
2. What is the influence of knowledge management on the level of job performance of librarians in universities, Ibadan, Oyo State, Nigeria

Hypothesis: There will be a significant relationship between knowledge management practices and job performance among librarians in universities, Ibadan, Oyo State, Nigeria.

Methodology

A cross-sectional survey research design was adopted. The population of the study comprised 46 librarians in two higher institutions in Ibadan, Oyo State, Nigeria. These universities are: University of Ibadan and Lead City University. Total enumeration was used in the study ensuring that all librarians were sampled. A structured questionnaire was used for the study to gather data from respondents. The data gathered were analyzed using descriptive statistics, correlation and multiple regression analysis at 0.05 level of significance.

Result analysis.

Finding indicated the level of job performance of participants in this study reported that out of the total respondents, 29 (63.0%) were male, while 17 (37.0%) were female, suggesting that more males than females. Regarding age distribution, 5 respondents (10.9%) were within the 20-30 years age range, 10 (21.7%) were aged 31-40 years, 17 (37.0%) fell within the 41-50 years category, while 14 (30.4%) were aged 51 years and above. This indicates the majority of the respondents were between 41 and 50 years old. However, the presence of 10.9% of respondents aged 30 years and below suggests that younger professionals are being integrated into the workforce. In terms of educational qualifications, 12 respondents (26.1%) held an HND, 22 (47.8%) possessed a B.Sc., 11 (23.9%) had a Master's degree, and only 1 (2.2%) had a PhD. This shows that most librarians in universities, Ibadan, Oyo State, Nigeria, Nigeria, are graduates, with 73.9% holding either an HND or B.Sc., while a smaller proportion (23.9%) have a Master's degree. Furthermore, work experience data revealed that 5 respondents (10.9%) had between 1-5 years of experience, 12 (26.1%) had worked for 6-10 years, 15 (32.6%) had 11-15 years of experience, 13 (28.3%) had been in service for 16-20 years, and 1 respondent (2.2%) had over 21 years of experience. The largest group of respondents (32.6%) had between 11-15 years of experience, indicating a well-experienced workforce. However, the presence of 10.9% of respondents with 1-5 years of experience suggests that new entrants are gradually joining the profession.

Research question 1: What is the level of job performance of librarians in universities, Ibadan, Oyo State, Nigeria?

Table 1: Level of Job Performance of Office Managers in Universities

	Items: I----------	VL	H	L	VL	$\bar{x}$	Std. dev
I	**Effectiveness and efficiency**						
1	take appropriate action on problem as necessary	24 (52.2%)	17 (37.0%)	5 (10.9%)	-	3.26	0.86

2	make appropriate priorities for tasks	12 (26.1%)	16 (34.8%)	9 (19.6%)	9 (19.6%)	2.68	0.75
3	work without supervision as necessary	12 (26.1%)	15 (32.6%)	11 (23.9%)	8 (17.4%)	2.65	0.74
4	have a clear professional goal	15 (32.6%)	28 (60.9%)	2 (4.3%)	1 (2.2%)	3.44	0.88
5	fulfill responsibilities within a short time	14 (30.4%)	30 (65.2%)	2 (4.3%)	-	3.38	0.86
II	**Facilitating peer and team performance**						
6	help to set specific challenging goals	15 (32.6%)	26 (56.5%)	5 (10.9%)	-	3.80	0.91
7	collaborate in order for me to plan my work	17 (37.0%)	21 (45.7%)	7 (15.2%)	1 (2.2%)	2.76	
8	share positive opinions about the team's ability to achieve objectives with the aim of motivating each other to complete tasks with my colleagues	16 (34.8%)	19 (41.3%)	10 (21.7%)	1 (2.2%)	2.96	0.79
9	integrating what I have learned from past performance	9 (19.6%)	33 (71.7%)	3 (6.5%)	1 (2.2%)	3.58	0.89
10	help my colleagues when they need it without being asked	7 (15.2%)	36 (78.3%)	2 (4.3%)	1 (2.2%)	3.56	0.89
	Average Mean: 3.21						

Decision Rule*: High =4.00-3.00, Moderate =2.99-2.00, Low =1.99-1.00, Very Low = 0.99-0.00* Source: Fieldwork, 2024

Table 1 above showed that with a calculated average mean of 3.21, it could be inferred that the level of job performance of librarians Universities in Ibadan, Oyo State, Nigeria is moderately high. This could be mean that librarians in these higher institutions help one another to set specific challenging goals, collaborate in order for them to plan their work and take appropriate action on problem as necessary as all these tend to enhance their job performance.

Research question 2: What is the influence level of knowledge management practices of librarians in universities, Ibadan, Oyo State, Nigeria?

Table 2: Influence Level of knowledge management practices of librarians in higher institutions

	Items	**VL**	**H**	**L**	**VL**	$\bar{x}$	**Std. dev**
I	**Knowledge Sharing**						
1	Knowledge is shared during group meetings	11 (23.9%	21 (45.7%)	8 (17.4%)	6 (13.0%)	2.15	0.76
2	Knowledge is shared using electronic means (websites, wikis, forums).	10 (21.7%)	23 (50.0%)	8 (17.4%)	5 (10.9%)	2.89	0.68
3	I share knowledge with colleagues who are my friends	20 (21.7%)	24 (73.9%)	2 (4.3%)	-	3.30	0.65
4	I share knowledge with colleagues from my department	17 (37.0%)	21 (45.7%)	7 (15.2%)	1 (2.2%)	3.75	0.80
5	I share knowledge with colleagues of other professional groups at the library	12 (26.1%)	16 (34.8%)	10 (21.7%)	8 (17.4%)	3.70	0.85
II	**Knowledge Accessibility**						
6	quickly find information about copyright and licensing issues relevant to my work.	15 (32.6%)	16 (34.8%)	12 (26.1%)	3 (6.5%)	3.04	0.84
7	easy access to the professional literature necessary for my role	13 (28.3%)	16 (34.8%)	10 (21.7%)	7 (15.2%)	3.30	0.81
8	quickly find information about best practices in academic librarianship	16 (34.8%)	20 (43.5%)	9 (19.6%)	1 (2.2%)	3.89	0.80
9	easily access training materials and professional development resources.	14 (30.4%)	19 (41.3%)	11 (23.9%)	2 (4.3%)	3.15	0.84
10	information about new technologies relevant to my work is easily accessible	16 (34.8%)	20 (43.5%)	10 (21.7%)	-	3.87	0.74

Average Mean: 3.30

Decision Rule*: High =4.00-3.00, Moderate =2.99-2.00, Low =1.99-1.00, Very Low = 0.99-0.00* Source: Fieldwork, 2024

With a calculated average mean of 3.30, it could be inferred that the level of knowledge management practices of librarians in universities in Ibadan, Oyo State Nigeria is moderately high. This means that knowledge sharing and knowledge accessibility of librarians which include sharing using electronic means (websites, wikis, forums) and finding information about best practices in academic librarianship could enhance their job performance.

Test of Hypothesis: There is no significant influence of Knowledge Management Practices on job performance of librarians in Universities, Ibadan, Oyo State Nigeria.

Table 4.5a: Influence of Knowledge Management Practices on job performance of librarians Universities, Ibadan, Oyo State.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.738[a]	.545	.512	3.09247

a. Predictors: (Constant), Innovative behavior,

The result produced a coefficient of multiple regressions R = 0.738 and multiple R-square = 0.545. This suggests that knowledge management practices has positive correlation with job performance accounted for 51.2% (Adj.R2= .512) variance in the prediction of job performance of librarians in universities, Ibadan, Oyo State, Nigeria. The other factors accounting for the remaining variance are beyond the scope of this study.

Discussion of Findings

Findings indicates that the job performance of librarians in universities in Ibadan, Oyo State, Nigeria, is moderately high. Librarians actively support one another, set challenging goals, collaborate on tasks, and take necessary actions to address problems, all of which enhance job performance. This aligns with studies on secretarial personnel, the hospitality industry in South Africa, and federal university secretaries in Southwest Nigeria, all of which reported a moderate level of job performance (Yesuf et al, 2014 & Onche, 2023). These studies emphasized the importance of communication, teamwork, organizational culture, and employee coordination in improving job performance. Effective communication practices, goal-setting, and clear role definitions were identified as key factors contributing to improved employee productivity across various sectors.

The finding reveals the level of knowledge management practices among librarians in universities in Ibadan, Oyo State, Nigeria is moderately high. Knowledge sharing and accessibility, including the use of electronic platforms and best practice research, contribute to improved job performance. This aligns with studies in federal university and public libraries in Southeast Nigeria, which found that knowledge creation, storage, sharing, and application significantly enhance librarians' efficiency, service delivery, and innovative practices(Ugwu, & Ekere, 2019). Additionally, effective documentation and retrieval systems were identified as key to improving user satisfaction and overall job performance(Bashir, Malik, & Mahmood,2021).

More so, the result from hypothesis (Beta = .747, t= 5.797, $p<0.05$), reveals that there was significant influence of knowledge management practices on job performance of librarians in higher institutions, Oyo State Nigeria. The finding corroborates a study that explored the influence of knowledge management on job performance in academic libraries in South-West Nigeria. They found that knowledge creation, sharing, and application positively influence librarians' performance, with knowledge sharing having the strongest impact (Bokoh, Ajiboye, & Bello, 2023).

Summary and Conclusion

Summarily, the study found that the level of job performance of librarians in higher institutions, Oyo State, Nigeria was moderately high. The level of knowledge management practices of librarians in higher institutions, Oyo State Nigeria was

moderately high. Knowledge management has significant influence on job performance of librarians in Universities, Ibadan, Oyo State. The study concludes that librarians in universities in Ibadan, Oyo State, Nigeria, Nigeria, exhibit a moderately high level of job performance, supported by effective knowledge management practices. The significant influence of knowledge management on job performance in universities in Ibadan highlights the importance of systematic knowledge sharing, storage, and application in enhancing librarians' efficiency. Institutions should therefore strengthen knowledge management strategies to further improve librarians' contributions to academic success. Library management must be deliberate in their effort in ensuring and maintaining a high-level job performance else any little slight can cause a drop in performance. Higher institutions should invest in knowledge-sharing platforms such as digital repositories, online forums, and professional workshops to encourage collaboration. Library management should understand the need for a supportive and knowledge-driven work environment to optimize librarians' contributions to institutional success via several programs, continuous development conference and so on.

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Maize Response to Varying Weed Control Times: Growth, Yield, and Correlation Insights

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ABSTRACT

Maize (*Zea mays* L.), a major global grain crop, suffers yield losses of up to 80% from weed competition if not timely managed, especially in sub-Saharan Africa. Early-season weed control enhances canopy development and grain formation, yet its combined effect on growth and yield remains underexplored. This study examined maize response to varying weed control times in Nigeria's rainforest agro-ecological zone using a Randomized Complete Block Design with four treatments: weed-free (0 WAP), weeding at 2 WAP, 4 WAP, and 6 WAP, replicated four times. Growth traits (plant height, leaf area, stem girth, leaf length, number of leaves) and yield components (cob length, cob weight, grain yield, 100-seed weight) were assessed. Early weed control (0–4 WAP) significantly improved vegetative growth (2–12 WAP) and yield, with weed-free plots producing the highest cob length (15.42 cm), cob weight (32.80 g), and grain yield (23.16 t/ha). Correlation analysis revealed strong positive relationships within growth and yield parameters, with only a weak negative correlation (-0.47*) between number of leaves and cob length. Findings confirm a critical weed control period within the first 4 WAP, essential for optimizing maize growth and yield.

Keywords: Correlation, Growth, Yield, Weed control time

1.0 Introduction

One of the main staple cereals and a key component of global food security is maize (*Zea mays* L.). In addition to being a vital food staple for humans, it is also a vital source of feed for animals and a raw ingredient for a number of industrial goods, including bioethanol and starch derivatives (FAO, 2023). With average yields of about 5.7 tons per hectare, maize is grown on more than 200 million hectares worldwide. However, insufficient fertilizer use, dryness, pests, diseases, but most importantly weed competition causes yield loss in sub-Saharan Africa making it to frequently falling below 2 tons per hectare (Smith & Johnson, 2021).

Weeds are significant biotic challenge to maize farming because they minimize growth and yield potential by competing with maize plants for water, nutrients, light, and physical space. There is about 30% to 80% loss in maize yields due to weed infestation and ineffective management (Ogunlela et al., 2022). Farmers frequently weed irregularly, either because of labor shortages, unpredictable rainfall, or a lack of awareness, which results in suboptimal yield outcomes. Some of the main issues are that, although early weeding is generally known to be beneficial, the precise weed-free critical period within local contexts is still not well defined. Without proper timing, early weed control may not be sufficient, while late weeding may be ineffective. Without evidence-based timing guidelines, some people fail to weed at the proper development stage or waste effort on pointless weeding. In order for extension initiatives and policies to support effective, yield-maximizing practices, it is imperative to produce empirical data on the effects of weed control scheduling on maize development and production under rainforest agroecological zone.

Although, it is an established fact that timely weed control, particularly in the first several weeks after maize emergence is essential because growth, canopy and root dominance which are difficult to prevent later are established at the early stage, of which the presence of weed at this period will have severe disproportionate competitive damage on maize growth (Zhou et al., 2020). Hence, integrated approaches and that delayed weeding beyond a critical weed-free period (usually 3–4 weeks after crop emergence) leads to sharp decreases in biomass accumulation and grain yield (Gomez &

O'Smith, 2023; Karim et al., 2024). Despite these discoveries, the relevance of many earlier researchers to local farming settings was limited because they were carried out in other climates or production systems and none have confirmed the relationships between the growth and yield parameters under a varied weed control time. Therefore, this study aims to investigate not just the effects of timing weed control interventions on maize growth dynamics and final yield in rainforest agroecological zone by comparing early weeding but also aim at investigating the relationship between the growth and yield parameters of maize.

2.0 Materials and Methods

The field experiment was conducted at the Teaching and Research Farm of Federal Polytechnic Ilaro located in Yewa South Local Government Ogun State, Nigeria between month of April and August 2025. An enhanced open-pollinated SAMMAZ 15 maize variety, which is commonly grown in Nigeria, was utilized for the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) having four treatments in each of the four blocks, which correspond to various weed control schedules; Weed-free for the entire time(0WAP/Control), weeding at two weeks after planting (2WAP), weeding at four weeks after planting (4WAP), and weeding at six weeks after planting (6WAP). Prior to planting, the land was prepared manually and the soil pulverized with the aid of local hoes, the seeds were planted on a raised bed, each drill hole got two seeds, which were thinned to a single, more vigorous stand two weeks after emergence (WAE). The planting space of 75 cm × 25 cm maize seeds resulting in 10 maize stands per plot (1m x 3m), 60 stands per block (10m x 25m) and 120 stands for the entire experimental field (45m x 110m). To reduce interference, there were 1 m alley between plots and 2 m between blocks. Fertilizer in the form of NPK 15:15:15 at the rate of 5g per stand at the 4week after planting and urea fertilizer of 5g per stand at 8 weeks after Planting.

In line with the experimental design, weed control measures were implemented and manually controlled with the aid of hoes at predetermined time intervals of 0, 2, 4, or 6WAP and were kept weed free till the end of the experiment after the allotted weed control time. Data on growth parameters were collected from three randomly chosen plants per plot were Plant height (cm) using a meter rule, measured every two weeks beginning at 2 WAP, from the soil surface to the tip of the highest leaf. Number of leaves by counting to determine the number of leaves on each plant. Leaf Length by using a measuring tape or ruler to measure from the leaf base to the leaf tip, Leaf width by using a tape measure or a ruler to measure across the leaf's broadest area, stem grith by Encircling venire caliper round the base part of the stem and Leaf Area was determined mathematically by the equation (i)

$$Leaf\ Area\ (LA) = Length\ X\ Width\ X\ 0.75$$

The data on yield parameters were collected at harvest (15WAP) from plants chosen at random, these include the number of cobs per plant by counted from plants. Cob diameter and length were measured with a ruler and vernier caliper. Grain weight per cob (g) was determined after shelling and drying to 12–14% moisture content. One hundred seed weight was determined using a weighing balance to weigh 100 seeds after counting and Grain yield was determined mathematically by equation (ii).

$$Grain\ Yield\ (kg/ha) = Yield\ per\ m^2\ X\ 10{,}000 \ldots\ldots\ldots\ldots (ii)$$

Data was analyzed with the aid of statistical Package for Social Sciences (SPSS version 21), by carrying out analysis of Variance (ANOVA) on the collected data and means were separated using Duncan multiple Range Test (DMRT) at a 5% probability level ($p \leq 0.05$). Additionally, correlation studies were performed to investigate the connections between maize growth and yield parameters.

3.0 Results and Discussion

Table 1 shows Leaf width differed significantly among treatments during the early growth stages indicating that the weed-free treatment consistently produced the widest leaves at 2 and 4 WAP (6.08 cm and 6.55 cm, respectively), which were statistically superior to delayed weeding treatments such as weed-free at 4 WAP (3.90 cm) and weed-free at 6 WAP (2.18 cm). This demonstrates that early weed competition significantly suppressed leaf expansion. Although some compensatory growth occurred in later weeks, particularly in the weed-free at 6 WAP treatment (7.90 cm at 14 WAP), plants never fully matched the continuous weed-free plots.

Table 1 on number of leaves per plant was also influenced by weed control time, weed-free at zero-week plots consistently produced more leaves during early and mid-growth stages, while weed-free at 6 WAP recorded the lowest counts early on (5.33 at 2 WAP). Later in the season, differences narrowed, suggesting partial recovery.

Table 2 Mean Performance of Number of leaves

TREATMENT	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
Weed Free at 0WAP	6.83^{a}	4.67^{a}	8.83^{a}	10.00^{a}	9.83^{a}	9.83^{a}	9.00^{a}
Weed Free at 2WAP	6.33^{ab}	8.33^{a}	8.50^{a}	8.67^{ab}	9.00^{a}	9.33^{a}	9.50^{a}
Weed Free at 4WAP	6.83^{a}	7.67^{a}	8.83^{a}	9.17^{ab}	9.67^{a}	9.50^{a}	8.83^{a}
Weed Free at 6WAP	5.33^{b}	5.17^{b}	6.17^{b}	8.00^{b}	9.83^{a}	9.83^{a}	9.00^{a}
LSD	0.09	0.01	0.00	0.04	0.36	0.74	0.41

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 3 shows that Stem girth has less consistent treatment weed-free at 4 and 6 WAP recorded significantly lower girth (2.63 cm and 3.68 cm respectively) compared to weed-free plots (4.11 cm). However, many treatments were statistically similar at later stages.

Table 3 Mean Performance of Stem Girth

TREATMENT	2WAP (cm)	4WAP (cm)	6WAP (cm)	8WAP (cm)	10WAP (cm)	12WAP (cm)	14WAP (cm)
Weed Free at 0WAP	5.25^{a}	5.93^{a}	6.12^{a}	7.28^{a}	5.98^{a}	5.32^{a}	4.88^{a}
Weed Free at 2WAP	3.75^{a}	6.25^{a}	6.02^{a}	6.92^{a}	4.88^{ab}	4.75^{a}	4.78^{a}
Weed Free at 4WAP	4.58^{a}	5.97^{a}	6.32^{a}	5.93^{a}	4.63^{b}	4.52^{a}	4.70^{a}
Weed Free at 6WAP	4.95^{a}	2.63^{b}	3.68^{b}	5.93^{a}	4.89^{b}	5.38^{a}	4.62^{a}
LSD	0.89	0.00	0.01	0.15	0.08	0.16	0.97

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 1 Mean Performance of Leaf width

TREATMENT	2WAP (cm)	4WAP (cm)	6WAP (cm)	8WAP (cm)	10WAP (cm)	12WAP (cm)	14WAP (cm)
Weed Free at 0WAP	6.08^{a}	6.55^{a}	7.80^{ab}	9.47^{a}	7.00^{a}	7.25^{a}	7.45^{a}
Weed Free at 2WAP	5.22^{ab}	6.22^{a}	8.45^{a}	8.67^{ab}	6.50^{ab}	6.55^{a}	5.50^{b}
Weed Free at 4WAP	3.90^{b}	6.37^{a}	5.62^{bc}	7.13^{c}	5.13^{b}	5.87^{a}	6.65^{ab}
Weed Free at 6WAP	2.18^{c}	3.42^{b}	4.78^{c}	6.55^{c}	5.67^{b}	6.77^{a}	7.90^{a}
LSD	0.00	0.00	0.00	0.01	0.11	0.49	0.04

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 4 shows leaf length followed a similar pattern to leaf width. Weed-free plots produced significantly longer leaves early (55.58 cm at 2 WAP) compared to weed-free at 6 WAP (23.42 cm). By 14 WAP, delayed weeding treatments exhibited partial catch-up (70.62 cm), but early canopy advantage of weed-free plots was evident.

Table 4 Mean Performance of Leaf Length

TREATMENT	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
Weed Free at 0WAP	55.58^{a}	63.43^{a}	67.22^{a}	68.90^{a}	62.58^{a}	63.37^{a}	63.52^{ab}
Weed Free at 2WAP	46.17^{b}	65.37^{a}	67.72^{a}	68.80^{a}	65.52^{a}	69.82^{a}	68.33^{ab}
Weed Free at 4WAP	62.17^{a}	58.77^{a}	66.47^{a}	67.58^{a}	67.58^{a}	58.87^{a}	55.97^{b}
Weed Free at 6WAP	23.42^{c}	30.47^{b}	39.88^{b}	50.43^{b}	63.83^{a}	68.02^{a}	70.62^{b}
LSD	0.00	0.00	0.00	0.13	0.85	0.23	0.13

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 5 shows Plant height was severely affected by weed competition, weed-free at 6 WAP plants were markedly shorter (17.18 cm) than weed-free plots (50.08 cm). Although some recovery occurred, weed-free plants consistently maintained height superiority throughout the growth cycle.

Table 5 Mean Performance of Plant Height

TREATMENT	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
Weed Free at 0WAP	50.08^{a}	69.67^{ab}	88.93^{a}	119.02^{ab}	130.17^{a}	136.48^{a}	135.57^{a}
Weed Free at 2WAP	43.00^{b}	78.25^{a}	88.93^{a}	97.23^{b}	114.77^{a}	128.07^{a}	131.28^{a}
Weed Free at 4WAP	59.75^{a}	59.82^{a}	101.83^{a}	121.50^{a}	130.48^{a}	131.12^{a}	129.73^{a}
Weed Free at 6WAP	17.18^{c}	24.50^{a}	32.23^{b}	48.08^{c}	68.57^{b}	104.78^{b}	116.72^{a}
LSD	0.00	0.00	0.00	0.00	0.00	0.02	0.27

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 6 shows Leaf area was significantly larger in weed-free plots (498.55 cm² at 8 WAP) compared to delayed weeding treatments. Weed-free at 6 WAP plants recorded drastically reduced early leaf area (73.35 cm² at 2 WAP), demonstrating the suppressive effects of early weed competition.

Table 6 Mean Performance of Leaf Area

TREATMENT	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
Weed Free at 0WAP	272.82^{a}	262.00^{b}	464.37^{a}	498.63^{a}	343.05^{a}	315.18^{a}	357.90^{ab}
Weed Free at 2WAP	250.18^{ab}	353.40^{a}	353.68^{a}	406.87^{a}	321.95^{a}	367.40^{a}	355.67^{ab}
Weed Free at 4WAP	253.33^{ab}	271.18^{ab}	418.95^{a}	458.39^{a}	292.18^{a}	273.55^{a}	247.38^{b}
Weed Free at 6WAP	73.35^{b}	78.63^{b}	145.82^{b}	248.47^{b}	278.20^{a}	352.67^{a}	418.95^{a}
LSD	0.09	0.00	0.01	0.01	0.69	0.46	0.15

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 7 shows Weed-free plots significantly outperformed other treatments for all yield parameters. Weed-free plants recorded the highest cob length (15.42 cm), cob weight (32.80 g), grain yield (23.16), and 100-seed weight (7.60 g). Conversely, delayed weed control reduced these yield attributes, with weed-free at 2 WAP and 6 WAP producing lower grain yield (19.36 and 20.06, respectively).

Table 7 Mean Performance of Yield Parameter

TREATMENT	Cob Length (cm)	Cob Weight (g)	100 seeds (g)	Grain Yield (Kg/ha)
Weed Free at 0WAP	15.42[a]	32.80[a]	7.60[a]	23.16[a]
Weed Free at 2WAP	12.72[b]	28.50[b]	6.22[b]	19.36[b]
Weed Free at 4WAP	14.40[ab]	28.00[b]	7.42[a]	20.82[ab]

Weed Free at 6WAP	13.66[ab]	27.20[b]	6.80[a]	20.48[ab]
LSD	0.050	0.03	0.46	0.15

Key: WAP- Week After Planting; LSD- Least Significant Difference. Means with the same letter along the columns are not significantly different using DMRT (P< 0.05)

Table 8 shows Correlation analysis (Table 4.8) highlighted cob length and cob weight as the strongest predictors of grain yield (r = 0.95** and r = 0.92**, respectively). This indicates that grain yield in maize is primarily determined by cob size

Table 8 Correlation of the Growth and Yield Parameters

	Plant Height	Leaf Area	Num. of Leaves	Leaf Length	Steam Girth	Leaf Width	Cob Length	Cob weight	Grain Yield	100Seeds (g)
Plant Height	1	0.27	0.63**	0.03	0.48*	-0.03	-0.30	-0.17	-0.28	-0.16
Leaf Area		1	0.48*	0.78**	0.28	0.28	-0.05	0.08	0.11	0.27
Num of Leaves			1	0.27	0.64**	0.19	-0.47*	-0.29	-0.40	0.04
Leaf Length				1	0.14	0.15	-0.09	-0.04	0.03	0.23
Stem Girth					1	0.22	-0.42	-0.34	-0.44	-0.14
Leaf Width						1	-0.13	-0.20	-0.06	-0.06
Cob Length							1	0.90**	0.95**	0.61**
Cob weight								1	0.92**	0.61**
Grain Yield									1	0.64**
100Seeds (g)										1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Growth Parameter

The Leaf width significant difference among treatments at the early growth stages is a reflection that early weed competition significantly suppressed leaf expansion. Towards the end of the growing stage, it was indicated that delayed weeding induced late compensation that broke the early growth stage predictive trend. This pattern aligns with previous reports that early-season weed competition critically reduces light and nutrient availability, thus constraining canopy development (Horvath, 2023; Nedeljković et al., 2025).

The number of leaves per plant was also influenced by weed management as weed-free plots consistently produced more leaves during early and mid-growth stages. Although early vigor predicts mid-season leaf production, late compensation disrupts this progression. These findings corroborate the critical period for weed control (CPWC) concept, where early weed interference directly affects canopy development and potential photosynthesis (Landau et al., 2021; Iowa State Extension, 2022).

Stem girth showed less consistent treatment effects compared to leaf traits; many treatments were statistically similar at later stages. It is less directly influenced by weed competition than leaf area and height. Previous studies have shown that stem girth is more strongly linked to lodging resistance than to yield potential (Zhao et al., 2023).

Leaf length followed a similar pattern to leaf width as weed-free plots produced significantly longer leaves at the early and mid-season of growth but again reflecting compensatory growth at the end of the growing session. This confirms that early canopy suppression by weeds limits photosynthetic potential, consistent with earlier reports (Bavec, 2002; Nedeljković et al., 2025).

Plant height was severely affected by weed competition although some recovery occurred, weed-free plants consistently maintained height superiority throughout the growth cycle. It implies that plant height is an important indicator of vigor and competitive ability in maize, with early weed-free conditions ensuring maximum light interception and growth (Yang et al., 2024).

Leaf Area compared to delayed weeding treatments demonstrate the suppressive effects of early weed competition but later reflect compensatory growth at the late session of growth. Since leaf area directly determines light interception and radiation use efficiency, early weed suppression inevitably reduced cumulative biomass production (Zhao et al., 2023).

Yield Parameter

Weed-free plots significantly outperformed other treatments for all yield parameters as delayed weed control reduced these yield attributes, with weed-free at 2 WAP and 6 WAP producing lower grain yield. These findings emphasize the importance of maintaining weed-free conditions during the critical period of maize development. Early weed competition restricts resource availability during ear formation, leading to smaller cob size and reduced grain fill (Nedeljković et al., 2025; Landau et al., 2021).

Relationship Between the growth and yield parameter

Correlation analysis highlighted cob length and cob weight as the strongest predictors of grain yield. This indicates that grain yield in maize is primarily determined by cob size.

Vegetative vigour traits (height, leaf area) were positively correlated with each other, confirming that canopy development is interdependent. Similar patterns have been documented in maize studies where reproductive traits are stronger yield determinants than vegetative traits (Horvath, 2023; Yang et al., 2024).

4.0 Conclusion

This study investigated the impact of varying weed control time on the growth, yield and correlation of both parameters. It is therefore discovered that **early weed control (0–4 WAP)** is crucial for sustaining maize growth and maximizing yield. Delayed weed removal was noticed to suppressed early vegetative traits, but a compensatory growth at the late growing session was observed with delayed weed removal (6 WAP). However, yield losses remained evident in maize whose weed removal was delayed despite the compensatory vegetive growth at the end of the session. It was also revealed from this research that high vegetative growth especially at the late session of maize production may not culminate in high yield only early and sustained vegetative growth of maize will bring about high yield of maize.

RECOMMENDATION

It is hereby recommended that Weed management should prioritize early-season control (first 2–4 WAP). Cob traits (length, weight) can serve as reliable predictors of yield in breeding and field assessments. And early vegetative vigour measurements (height, leaf area) are strong indicators of future yield performance and can guide early interventions.

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Nutritional Qualities and Comparative Acceptability of Self Developed Flakes and Balls Produced from Oat and Cocoa Beans

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ABSTRACT

This study investigated the nutritional qualities and comparative acceptability of self-developed ready-to-eat flakes and balls produced from oat and cocoa beans. Fifty academic staff from departments that were offering courses relating to food at The Federal Polytechnic, Ilaro, Ogun State were purposively chosen as sensory panelists. Sensory evaluation was conducted using a 9-point hedonic scale rating, and the data obtained were analyzed using descriptive and inferential statistics, like mean, median, standard deviation and Analysis of Variance (ANOVA) using Statistical Package for Social Science SPSS version 30.0, The sensory results showed mean scores ranging from 6.30 to 7.50 for appearance, colour, aroma, texture, taste, flavour, fluffiness, and overall acceptability. These findings indicate that the flakes and balls were generally well accepted, with the flaked products performing slightly better in texture and crispness. Proximate analysis results revealed variations in moisture (22.65-25.65 **%**), ash, (1.38-2.08 %) crude protein (4.33-4.60 %), crude fiber (0.32-0.95 %), fat (1.18-1.97 %), and carbohydrate (69.88-65.15%) contents. The composite formulations demonstrated improved nutritional quality compared to the control samples, with higher protein and fiber levels, moderate fat and carbohydrate contents, and appreciable mineral composition reflected in ash values. The study recommends that blending oat and cocoa in product development enhances both nutritional quality and consumer acceptability, food producers should prioritize using oat –cocoa composite flour in flakes and balls productions as they provide affordable, and acceptable alternatives to conventional breakfast cereals, with potential to promote healthier dietary choices.

Keywords: Breakfast cereals, Nutritional Acceptability, Proximate evaluation, Sensory attributes

1.0 Introduction

Flaked cereals are produced from grains that are boiled, mechanically processed, and flattened into thin pieces known as flakes. Common raw materials include corn, wheat, and rice. In the typical production process, grains such as maize, wheat, or rice are milled into grits, cooked with flavouring like sugar or syrups, and then compressed between cooled rollers to form thin flakes (Robin &Palzer, 2019). These flakes are often roasted to achieve a crisp texture and are commonly consumed cold with milk or other accompaniments (Lignicka & Galoburda, 2022). They can also be crushed for use as crunchy toppings or as a substitute for breadcrumbs in baking (Fayet-Moore et al., 2020). Popular varieties include sugar-coated, honey nut, frosted, and multigrain flakes (Kruma et al., 2020). The earliest known flaked cereal, Granose, was created accidentally by John Harvey Kellogg and Will Keith Kellogg in 1894 while developing easily digestible foods for sanitarium patients. Their discovery occurred when cereal dough was inadvertently left to ferment, then rolled into thin flakes and baked until crisp (Huang &Perdon, 2020).

Ball cereals are another type of breakfast product distinguished by their small, spherical shape. They are typically made from processed grains such as corn, wheat, or rice, which are shaped through extrusion or other moulding techniques. Production involves mixing cereal grains with water to create a dough or slurry, which is then extruded or moulded into small pellets. These pellets are subsequently cooked, dried, and often coated with flavouring such as chocolate or sugar syrups to enhance taste and texture. Their unique shape and sweet flavour make them especially appealing to children.

Oats (Avenasativa) have a long and intricate history, originating from wild species that were gradually adopted for food and fodder thousands of years ago.

They are believed to have originated in the Mediterranean and Near Eastern regions, with the wild progenitor Avenasterilis still found in the Fertile Crescent (Leszczyńska et al., 2023). Genetic studies suggest that cultivated oats emerged roughly 3,000 years ago in Europe, likely as a secondary crop initially viewed as a weed in fields of wheat and barley (Mao et al., 2022). Archaeological findings from Southern Italy and the Jordan Valley indicate that wild oats were consumed by hunter-gatherers as early as 32,000 years ago. Over time, oats have served as a staple for both humans and animals and are used in porridge, oatcakes, muesli, and traditional dishes in regions such as Wales and Scotland (Abdulwaliyu et al., 2019). Recently, oat milk has grown rapidly in global popularity as a plant-based dairy alternative (Kozinska et al., 2021). Nutritionally, oats are rich in carbohydrates (mainly starch), proteins (11–15%), lipids (5–9%), fibre, and phytochemicals. They are especially valued for their high soluble fibre content—particularly β-glucan (2.3–8.5%)—which is known to support cholesterol reduction and cardiovascular health (WHO, 2020). They also contain key micronutrients, including vitamin E (tocopherols and tocotrienols), minerals such as iron, zinc, and selenium, and phenolic antioxidants such as avenanthramides (Scalbert et al., 2024).

Cocoa beans represent a high-value cash crop essential to the livelihoods of millions of farmers, especially in West Africa, where cocoa cultivation supports large portions of national populations and contributes significantly to GDP (Yusuf et al., 2021). Despite the crop's economic importance, farmers often receive only a small share of the final retail value due to complex supply chains that limit profitability and reinvestment (Younes, Li &Karboune, 2023). The global cocoa market exceeded $15 billion in 2023, driven by increasing demand for chocolate and cocoa products (Panak-+Balentić et al., 2019). Cocoa beans are nutrient-dense, containing 40–50% lipids, substantial fibre, protein, and minerals such as magnesium, iron, potassium, copper, and zinc. They also provide bioactive compounds—including flavonoids, theobromine, and caffeine—that support cardiovascular, metabolic, and cognitive health (Hussain et al., 2018). Cultivation involves harvesting pods, fermenting and drying beans to develop flavour, and increasingly incorporating sustainable farming practices to manage pests, diseases, and climate-related challenges (Agus& Mohamed et al., 2020). Globally, cocoa remains a major agricultural commodity, valued at $9.59 billion in international trade in 2021. Along the "Cacao Belt"—including Côte d'Ivoire, Ghana, and Ecuador—it serves as a major export crop and a vital source of foreign exchange and employment. Compositionally, cocoa beans (*Theobroma cacao*) contain more than 40% lipids, 12–13% protein, over 32% carbohydrates, and roughly 11–19% fibre (Gadhe et al., 2023).

Although cocoa beans, oats, and other supplementary ingredients have been widely used in various products, their combined potential to enhance the functional benefits of cocoa and oats has not been thoroughly explored. Most existing studies focus primarily on the physical characteristics of cocoa and oats, often overlooking the synergistic health advantages that may arise when they are blended with other nutrient-rich components. Oats are recognized for their high fiber content and heart-health benefits, while cocoa is rich in antioxidants, flavonoids, and mood-enhancing compounds. However, research investigating their combined use in functional food formulations remains limited. This gap highlights the need for further studies aimed at developing innovative products that can improve health outcomes and appeal to consumers. Closing this research gap could lead to the creation of novel foods that capitalize on the complementary nutritional and therapeutic qualities of both cocoa and oats. Evaluating these products is essential to determine their taste, texture, and consumer acceptability.

The objectives of the study is to Prepare the various samples of flakes and balls, determine the nutritional qualities of self-developed flakes and balls produced from oat and cocoa, determine the sensory qualities of the various samples of cocoa and oat flakes and balls produced, compare the overall acceptability of the samples of the flakes and ball and Identify the customer preference for the various samples of self-developed oat and cocoa flakes and balls..

Flaked cereals emerged in the late nineteenth century during various health reform movements. The first commercially available ready-to-eat cereal, created in 1863 by health advocate Dr. James Caleb Jackson, was called 'Granul'. Produced from baked graham flour dough broken into hard nuggets, it required soaking before consumption due to its toughness (Smith, 2021). A major breakthrough came from the

Battle Creek Sanitarium in Michigan, where Dr. John Harvey Kellogg and his brother Will Keith Kellogg accidentally left cooked wheat dough out overnight in 1894. When they rolled the dough the next day, it separated into flakes, which they then baked and served to patients (Witnauer, 2019). This accidental discovery—later known as *tempering*—became fundamental to flake cereal production. Recognizing its commercial potential, Will Kellogg found the Battle Creek Toasted Corn Flake Company (later the Kellogg Company) in 1906, introducing corn flakes to the broader public. His addition of sugar to enhance flavor, however, caused tension with his brother John, who opposed sweetening the product.

As cereal manufacturers explored new forms and textures to attract consumers, ball-shaped cereals were introduced. General Mills launched **Kix** in 1937, one of the earliest puffed corn ball cereals. In the UK, Nabisco released **Golden Nuggets** in the 1970s—a honey-sweetened puffed maize cereal—which was later discontinued and then reintroduced in 1999 due to renewed demand (Toussaint-Samat, 2019). General Mills also debuted **Cocoa Puffs** in 1958, chocolate-flavored puffed maize balls often marketed to children through playful shapes and appealing taste (Anderson et al., 2021). The introduction of flake and ball cereals revolutionized breakfast habits by providing convenient, ready-to-eat options (Smith et al., 2021), a trend strongly supported by promotional strategies such as mascots and television advertisements. Notably, Kellogg's introduced the iconic character **Tony the Tiger** for Frosted Flakes in 1952.

Nutritional Properties of Oats and Cocoa Beans

Breakfast cereals made from oats (*Avena sativa*) and cocoa beans (*Theobroma cacao*) combine two nutrient-dense plant ingredients. Together, they provide valuable macronutrients, essential micronutrients, dietary fiber, antioxidants, and several health-promoting bioactive compounds.

Macronutrients

Oats supply energy through complex carbohydrates, contain comparatively high levels of protein for a cereal grain, and include mainly unsaturated fats. They are also rich in dietary fiber, particularly beta-glucan—a soluble fiber known for its cholesterol-lowering effects.

B. Micronutrients

Key micronutrients in oats include iron (crucial for blood formation), magnesium (important for muscle and nerve function), zinc (supports immune health), phosphorus (essential for bone strength), and B-vitamins such as thiamine (B1) and pantothenic acid (B5).

C. Health Benefits

Oats promote cardiovascular health by lowering LDL cholesterol, help regulate blood sugar due to slowed digestion and glucose uptake from beta-glucan, and enhance satiety, supporting weight management. The EFSA Journal (2021) notes that "oats are a unique source of soluble fiber, especially beta-glucan, which has clinically proven effects on cholesterol and glycemic response."

2.0 Materials and Method

Materials for the Study and Sources

The cocoa powder, sugar syrup, oats, and honey, utilized in this study were sourced from Sayedero Market in Ilaro, Ogun State, Nigeria, while water was gotten from the Federal Polytechnic, Ilaro, Hospitality Management Technology kitchen.

Samples' Formulation Table

Table 3.1: Showing the Sample Formulations for Flakes and Balls Samples

Samples	Oat Flake	Oat Ball	Cocoa Flake	Cocoa Ball
OF	100	0	0	0
OB	0	100	0	0
CF	0	0	100	0
CB	0	0	0	100
OCF 1	50	0	50	0
OCB 1	0	50	0	50
OCF 2	**50**	**0**	**50**	**0**
OCB 2	**0**	**30**	**0**	**70**

Samples' Preparation Table for the Control and Composite Blends

Samples	Oat flour (g)	Cocoa Powder (g)	Maple Syrub(ml)	Honey(ml)	Sugar (ml)	Water Litre
OF	**100**	**0**	**7.5**	**60**	**15**	**0.24**
OB	**100**	**0**	**7.5**	**60**	**15**	**0.24**
CF	**0**	**100**	**7.5**	**60**	**15**	**0.24**
CB	**0**	**100**	**7.5**	**60**	**15**	**0.24**
OCF 1	**30**	**70**	**7.5**	**60**	**15**	**0.24**
OCB 1	**30**	**70**	**7.5**	**60**	**15**	**0.24**
OCF 2	**50**	**50**	**7.5**	**60**	**15**	**0.24**
OCB 2	**50**	**50**	**7.5**	**60**	**15**	**0.24**

Samples' Key:

OF: Control Flakes (100% Oat flour)

OB: Control Balls (100% Oat flour)

CF: Control Flakes (100% Cocoa Powder)

CB: Control Balls (100%Cocoa Powder)

OCF1: Composite Flour Flakes (70:30)

OCB1: Composite Flour Balls (70:30)

OCF2: Composite Flour Flakes (50:50)

OCB2: Composite Flour Balls (50:50)

Preparation of Oat Balls and Oat flake Cereal (Control Sample OF and OB)

Procedure:

The unrefined oat was blended into powder form and maple syrup was added into the oat flour and mixed gently till firm. After this, honey and sugar were added, and then mixed together. Water was added little by little to the mixture and mixed gently till it became a softened solid dough and, this was divided into two halves. The dough was molded one half into small round balls and the second half of the dough was cut into slim flakes and they were coated with little sprinkle of oat flour. The baking tray was coated with little flour and the ball and flake cereal were gently and neatly arranged on it, The oven was preheated to about 150°C and the balls and flakes were put into the heated oven to bake for 20 - 25 minutes after which the tray was removed from the oven to let flakes and ball cool on the cooling rack, .

Preparation of Cocoa Flakes and Cocoa ball Cereal (Control Sample CF and CB)

Procedure

The dehulled Cocoa beans were blended into powder form and the maple syrup was added into the oat flour and mixed gently till firm, Honey and sugar were added to the mixture and mixed together; Water was added little by little till it became a softened solid dough. The dough was cut out into small pieces of slim flakes and coated with flour, the baking tray was greased and dusted or coated with little flour and the flake cereal were gently arranged and neatly arranged on it; The oven was preheated to about 150°C,The flakes and balls were put into the heated oven to bake for 20 - 25 minutes and this was removed from the oven and let cool on the cooling rack,.

Preparation of Oat and Cocoa Flakes and Ball Cereal (Composite Sample OCF1, OCB1, and OCF2, OCB2)

Procedure

The dehulled cocoa beans and the unrefined oat were blended into powder form and two flours were mixed at the same ratio 50: 50 for **Sample OCF1, OCB1**, and ratio 70: 30 for **Sample OCF2, OCB2 respectively.** The honey, maple syrup and sugar were added to the composite flour and this was

mixed together, water was added little by little till it became a softened solid dough, one half of the dough was molded into small round balls and the second half of the dough was cut out into slim flakes and both were coated with little sprinkle of oat flour. The baking trays were coated with little flour and the flake and ball cereal were gently and neatly arranged on it; the oven was preheated to about 150°C and the balls and flakes were put into the heated oven to bake for 20 - 25 minutes. The flakes and balls were then removed from the oven and let them cool on the cooling rack,

Preparation of sample Oat Ball Cereals

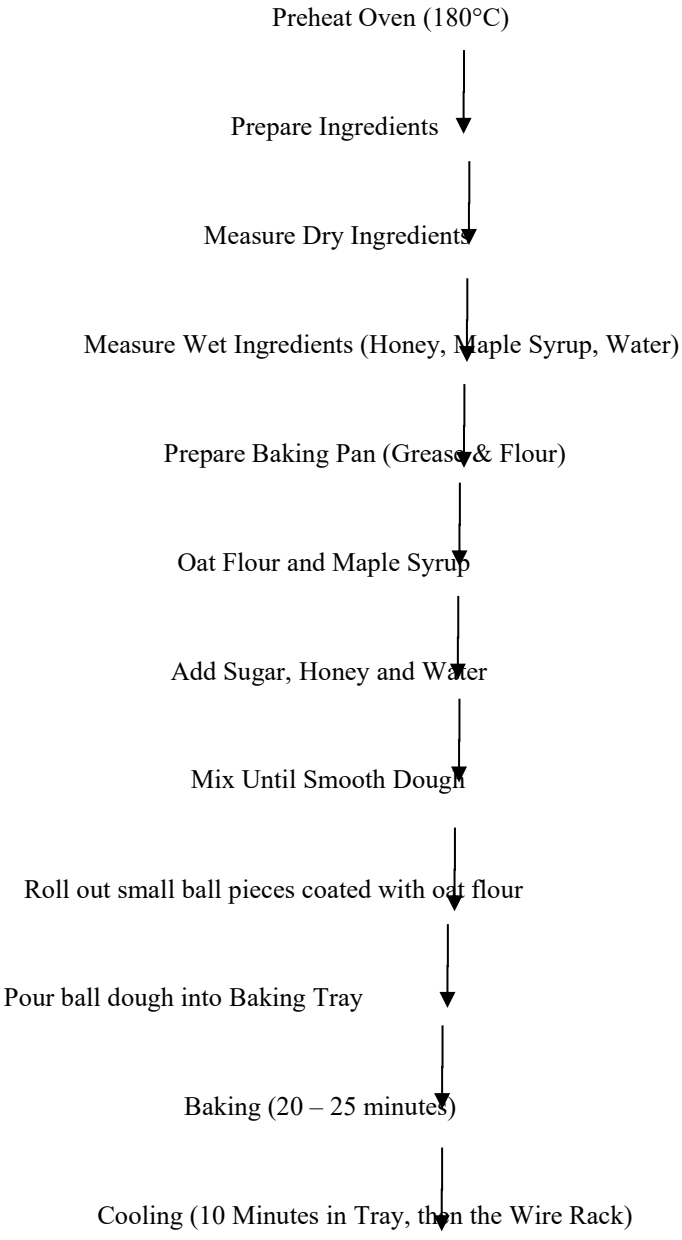

Fig.1 Flow chart for the preparation of sample Oat ball Cereals

Preparation of sample Oat Flake Cereals

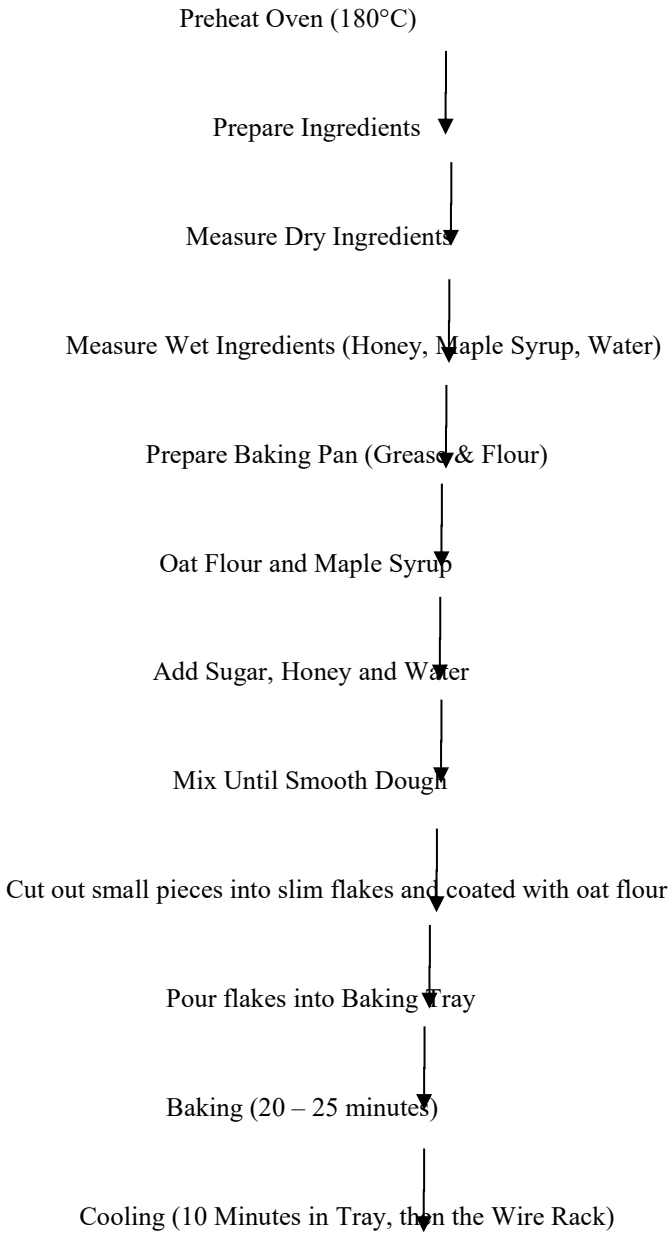

Fig.2 Flow chart for the preparation of sample Flake Cereals

Research Instrument

This study employed a sensory evaluation sheet as the primary research instrument, based on the nine-point hedonic rating scale arranged in descending order as follows: 9 – Dislike extremely, 8 – Dislike very much, 7 – Dislike moderately, 6 – Dislike slightly, 5 – Neither like nor dislike, 4 – Like slightly, 3 – Like moderately, 2 – Like very much, and 1 – Like extremely. The forms were given to the taste panelists for the sensory assessment of the different samples.

Source of Data

Both primary and secondary sources of data were used for this research. The primary data were obtained through the sensory evaluation forms completed by the panelists. Secondary data were gathered from textbooks, journals, periodicals, research papers, and credible internet sources.

Research Population/ Panelists

The research population consisted of academic staff members from food- and beverage-related departments within the School of Pure and Applied Sciences at The Federal Polytechnic Ilaro. Sample preparation was conducted in the Food Preparation Laboratory of the Department of Hospitality Management and Technology.

Sampling Size and Techniques

The sample size for the study consisted of 50 taste panelists selected from various food-related departments within the School of Pure and Applied Sciences, Federal Polytechnic Ilaro. Their selection was based on their expertise and background in food-related fields.

Validity and Reliability

To ensure the validity and reliability of the study, appropriate and adequate data collection ***methods were used, and the sample was carefully selected and properly analyzed. The information gathered and the analytical methods applied were guided by an objective*** framework and aligned with the study's predetermined goals, ensuring clarity and minimizing ambiguity. Additionally, all corrections and recommendations provided by the project supervisor were strictly adhered to.

Research Design

A quantitative survey research design was adopted for this study. A selected sample from the target population was used to obtain accurate and relevant data that ***addressed the research questions. Se***nsory evaluation served as the primary method of data collection, and the data obtained were analyzed to provide comprehensive information about the various samples.

Method of Data Analysis

Data analysis involved both descriptive and inferential statistical methods. Descriptive tools such as mean, median, and standard deviation were utilized. Analysis of Variance (ANOVA) was employed to determine significant differences in the mean sensory scores among the samples. Statistical analysis was conducted using SPSS (Statistical Package for the Social Sciences) version 30.0. Proximate composition analyses were carried out following AOAC (2023) procedures. The Duncan Multiple Range Test was used to identify significant differences among samples, while the LSD test ($P < 0.005$) was applied to further differentiate the mean values.

3.0 Results and Discussion

Results of the Sensory Qualities of the Various Samples

Table 1 below presents the sensory evaluation results of the various samples. The mean values of the samples ranged between 6.77 - 7.06, 6.76 - 6.36, 6.60 - 6.46, 6.55 - 6.22, 6.77 - 6.30, 6.60 - 6.52, 6.42 - 6.78, 7.50 - 7.28 in terms of appearance, colour, aroma, texture, taste, flavor, fluffiness, overall acceptability. The general higher mean values recorded in term of appearance were samples OF, CF, OB, and CB which are the control samples. This could be due to the colour and texture. The look of a mixture of oat flour and cocoa powder can be affected by many things, such as the temperature at which it dries, the ratio of ingredients, the cocoa content, the fat content, the processing methods, and other additives. All of these things together may be due to the colour, texture, and general look of the finished product. Zhao., & Lin (2021).According to Oluwole and Fawole(2022),this discusses the impact of processing conditions (temperature, drying rates, ingredient ratio) on sensory attributes, such as appearance, texture, and flavor, which are relevant to the discussion of how these factors affect composite flour product, which is likely due to the fact that they all had a consistent and familiar colour without any changes, which made them look more consistent and appealing to the panelist's than the composite samples, which may have had intermediate shades or less uniformity (Lawless &Heymann, 2020; Spence, 2025

However, samplesOCF2 has the highest mean score in colour, this shows that the colour of the mix of oat flour and cocoa powder is better since it was a more balanced and attractive medium-brown colour, the blended colour looks like chocolate-based goods that people are used to, which gives the impression

of quality and indulgence while also making the product look gentler and more inviting, which makes people more likely to buy it (Afoakwa, 2020; Spence, 2019; Lawless &Heymann, 2020).Sample OCB1 has the highest in terms of aroma because the smell of composite flour has a more balanced and pleasant character. It combines the mild, nutty, and somewhat sweet smell of oats with the rich, roasted, and chocolate-like smell of cocoa when mixed together, they make a smell that is both familiar and indulgent. (Afoakwa, 2020; Misnawi et al., 2022; Lawless &Heymann, 2020). Sample OCF1 has the highest mean score in texture, taste and flavor because the unique flavour from composite flour slightly improved the flavour profile of the composite flour and the combination of composite flour makes the mouthfeel smoother and more pleasant than either ingredient alone, but the difference was not statistically significant. Samples OCF1, OCB1, OCF2, and OCB2, which were made with composite flour, did much better on sensory qualities. This preference shows how composite flour changes the way things feel. The samples of composite flour had a better colour, texture, and smell, which made it more appealing overall. Studies show that composite flours can make sensory qualities better, especially when it comes to look and feel, which are important for making customers happy (Ajayi& Ojusa,2020; Mahato et al., 2021).The composite flour's great sensory performance suggests that composite flour flakes and balls might be more popular in markets where these sensory features are important

This research focuses on the sensory enhancement of composite flour blends, specifically oat flour and cocoa powder, aligning with the study on how these ingredients affect the color, aroma, and flavor profile of the final product, (Ghosh and Mishra, 2021).This conclusion is in line with what Ghoshal et al. (2020) found, which was that composite flour products had very little texture and flavour changes. Sample OCF2 has the highest overall acceptability with a little significant difference with the other composite samples, which is because of how the flakes look, smell, and feel. It indicates that the composite flour composition was predominantly more attractive. The notable disparity in overall acceptability ($p < 0.05$) underscores the composite flour's beneficial effect on sensory appeal, corroborating the results of Ghoshal et al. (2020) and Tao & Cho (2020).

Table 1: **Showing the Sensory Qualities of Flake and Oat Samples(%)**

Samples	Appearance	Colour	Aroma	Texture	Taste	Flavour	Fluffiness	Overall Acceptability
OF	7.06±1.74^{a}	6.36±2.08^{a}	6.46±1.98^{a}	6.22±2.21^{a}	6.30±2.19^{a}	6.52±2.13^{a}	6.78±1.87^{a}	7.28±1.86^{a}
CF	6.90 ±1.86^{a}	6.65±2.02^{a}	6.18±2.40^{ab}	6.31±2.22^{a}	6.84±1.89^{ab}	6.14±2.29^{a}	5.98±1.87^{a}	7.35±1.72^{a}
OB	6.99 ± 1.73^{a}	6.83±1.91^{a}	6.58±1.82^{ab}	6.47±2.28^{a}	6.71±2.19^{ab}	6.44±2.14^{a}	6.20±2.25^{a}	7.24±1.69^{a}
CB	6.57 ± 2.17^{a}	6.55±2.06^{a}	6.47±1.84^{ab}	6.45±2.04^{a}	6.57±1.95^{ab}	6.71±2.30^{a}	6.25±2.31^{a}	7.53±1.76^{a}

OCF1	6.68 ± 1.79 [a]	6.98±1.81[a]	6.94±2.03[ab]	6.96±1.77[a]	7.30±1.85[b]	7.02±1.64[a]	6.50±2.17[a]	7.72±1.72[a]
OCF2	6.61±2.18[a]	7.04±1.88[a]	6.55±1.72[ab]	6.90±1.84[a]	6.96±1.89[ab]	6.71±2.23[a]	6.69±1.98[a]	7.80±1.58[a]
OCB1	6.40±1.99[a]	6.85±2.05[a]	7.04±1.93[b]	6.63±2.21[a]	6.77±2.49[ab]	6.81±2.18[a]	7.77±2.32[a]	7.79±1.97[a]
OCB2	6.95±1.89[a]	6.82±1.98[a]	6.62±1.88[a]	6.48±2.02[a]	6.73±1.94[a]	6.48±2.12[a]	6.21±1.94[a]	7.30±1.82[a]

Source:FieldSurvey,2025

Values are represented as mean with standard deviation of responses from panelist (n= 50). Means with same or no letters within the same column are not significantly different (p>0.05), separated using the Tukey's HSD test at 5% confidence interval.

Samples' Key:

OF: Control Flakes (100% Oat flour)

CF: Control Flakes (100% Cocoa Powder)

OB: Control Balls (100% Oat flour)

CB: Control Balls (100%Cocoa Powder)

OCF1: Composite Flour Flakes (70:30)

OCF2: Composite Flour Flakes (50:50)

OCB1: Composite Flour Balls (70:30)

Proximate Composition of Oat and Cocoa Flakes and Balls

Table 2 shows the proximate composition attributes of the samples OB, OCB1, OCF1, OCB2, and OCF2. The moisture content (%) of the sample ranged between 22.65-25.65, the ash content (%) of the sample ranged between 1.38-2.08, the fat content (%) of the sample ranged between 1.18-1.97, crude fibre (%) of the sample ranged between 0.32-0.95, crude protein (%) of the sample ranged between 4.33-4.60, carbohydrate (%) of the sample ranged between 69.88-65.15.

Sample OCF2 has the highest moisture content in the mean value because there was a direct link between the amount of protein in the Oat flour and the amount of Cocoa powder added. According to Jayasena and Seneviratne. (2021) and Sablani and Saleh (2019), the amount of Cocoa powder added grew from 30% to 50% across the samples, the amount of protein also increased. The results were in line with what (Owoso, Aluko & Banjoko, 2020) and (Adeyeye and Akingbala, 2023) which makes Sample OCB2 has the highest in protein mean value and fat, cereals usually don't have much lysine but do have a lot of methionine. Globulin proteins, on the other hand, have more lysine. Onabanjo and Dickson (2020) states that the amount of moisture in cereal products is very important because it affects how long they last, how easy they are to store, and how stable they are for microbes. The moisture levels here aren't too high or too low, so the products should stay stable. They will still need to be packaged correctly, though.

This complimentary impact improves the essential amino acid profile, which makes the composite more complete and good for people to eat. Elemo et al. (2021) found similar results, saying that adding legumes or cocoa to cereals makes them much richer in minerals and moisture. Globulins also help in emulsification and foaming, which can make cereal-based dishes taste, look, and feel better (Aremu, Abioye, & Ibrahim,) (2023). The rise in ash, fat, and fiber levels is because cocoa powder has more minerals, cocoa butter, and dietary fiber than oat flour (Aremu et al., 2020; Beckett, 2022).This suggests that composite formulations enhance dietary fiber content, which is advantageous for gastrointestinal health, as corroborated by Ojinnaka et al. (2023).Sample OB has the highest in carbohydrate content due to diminished cocoa powder content in the control sample as oat is a good source of carbohydrate as reported by FAO/WHO (2023).

Table 2: Proximate Evaluation of the Flake and Oat Samples

Samples	Moisture content	Ash	Fat	Crude Fibre	Crude protein	CHO
OB	22.65±0.84 ^{a}	1.38±0.05 ^{ab}	1.18±0.11 ^{a}	0.32±0.36 ^{a}	4.33±0.67^{b}	69.88±1.53^{b}
OCB1	24.46±0.62^{bc}	0.93±0.13 ^{a}	1.98±0.03^{b}	0.67±0.06 ^{ab}	2.62±0.57 ^{a}	69.36±0.23^{b}
OCF1	23.53±0.45 ^{ab}	0.78±0.16 ^{a}	1.82±0.09^{b}	0.42±0.09 ^{ab}	4.02±0.05^{b}	69.47±0.81^{b}
OCB2	22.63±0.49 ^{a}	2.33±0.03^{c}	4.20±0.04^{c}	0.97±0.11^{b}	5.06±0.07^{b}	64.90±0.64 ^{a}
OCF2	25.65±0.53^{c}	2.08±0.70^{bc}	1.97±0.25^{b}	0.95±0.33^{b}	4.60±0.54^{b}	65.15±1.25 ^{a}

Source:FieldSurvey, 2025

Values are the average of three values plus or minus the standard deviation.

At P<0.05, the mean values in the column with different superscripts are very different from each other.

SamplesKey

Sample OB: Control Balls(100%Oatflour)

Sample OCB 1: Composite Flour Balls (70:30, Oat flour; Cocoa Powder)
Sample OCF1: Composite Flour Flakes(70:30, Oatflour; Cocoa Powder) **Sample OCB** 2: Composite Flour Balls (50:50, Oat flour; Cocoa Powder)

Sample OCF2: Composite Flour Flakes (50:50, Oatflour; Cocoa Powder)

4.0 Conclusion

In summary, flakes and balls made with different proportions of composite flour offered both appealing taste and improved nutritional value. The proximate and sensory analyses demonstrated the functional benefits of combining oat and cocoa powders. While 100% oat flour controls were richer in carbohydrates, incorporating cocoa increased

protein, fat, fiber, and ash content, improving overall nutrient balance. This enrichment is important as it diversifies the diet and provides nutrients not found in single-flour products.

Sensory evaluations showed that oat–cocoa blends were generally preferred over controls in terms of flavor, aroma, texture, and overall acceptability. Cocoa addition enhanced flavor, improved texture, and increased palatability, making these products more desirable.

These findings indicate that oat–cocoa flakes and balls offer a nutritious, cost-effective, and appealing breakfast option. They have potential to promote healthier eating habits, address micronutrient deficiencies, and increase the attractiveness and functionality of cereal-based foods.

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