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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

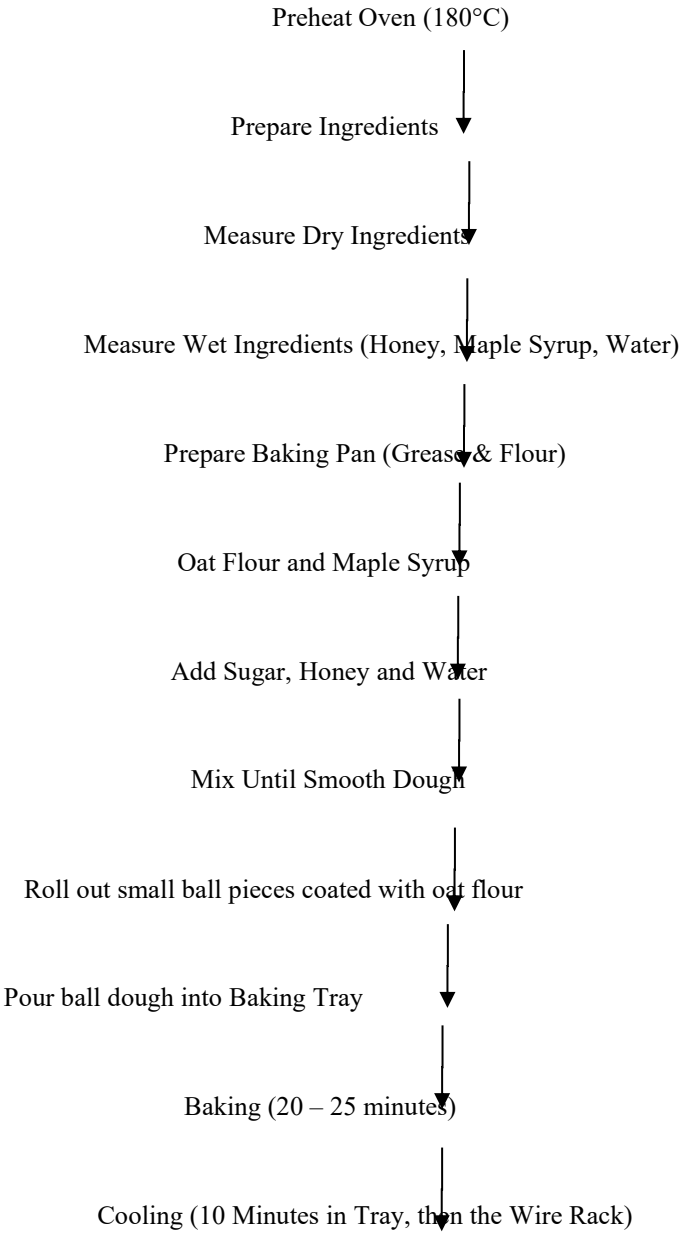

Fig.1 Flow chart for the preparation of sample Oat ball Cereals

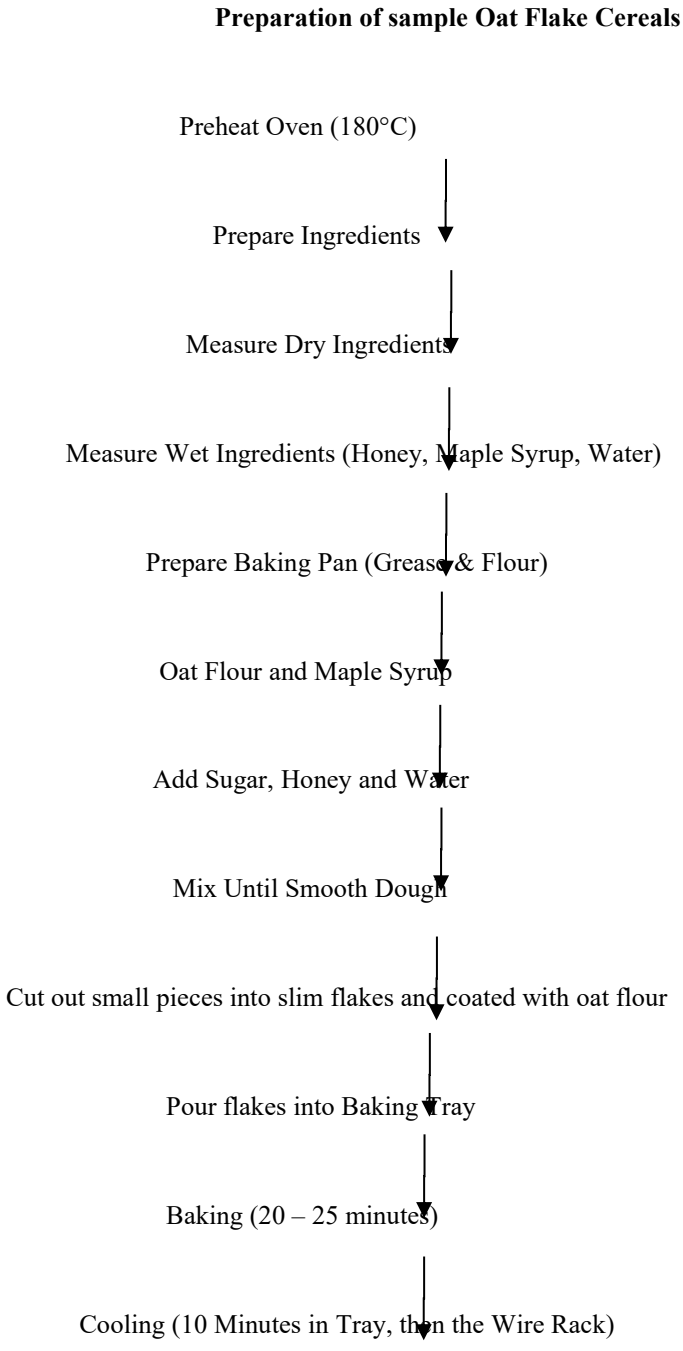

Fig.2 Flow chart for the preparation of sample Flake Cereals

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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