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Complementary Foods Formulated from Orange-flesh Sweet Potato, Soybean, and Date Palm Flour Blends Improves the Proximate, Rheological and Sensory Properties of Children's Formulas

Peter Abuengmoh^{1*}, Dick Iorwuese Gernah², Dinnah Ahure³, Kelly Ndombow Yakum¹

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ABSTRACT

This study evaluated the proximate, rheological and sensory properties of complementary foods produced from orange flesh sweet potato, soybean and date palm flour blends. Complementary foods were produced from orange flesh sweet potato (OFSP), soybean and date palm flour blends. The samples were formulated by material balancing with all samples having 16% protein/ 100g. The samples were coded as CON, CFA, CFB, CFC, CFD and CFE with sample CON being the control. The samples were subjected to rheological and sensory analysis using standard method. Their proximate composition were; moisture (2.51-7.38%), ash (2.27-3.02%), fibre (2.11-4.22%), fat (9.13-10.11%), protein (15.12-16.11%), and carbohydrate (63.06-65.01%). Rheological properties of the gruels were as follows; consistency index (m) (90.57-186.21 Nsⁿ/m²), Flow behaviour index (n) (0.256-0.411), Coefficient of regression (r²) (0.9765-0.9928) and Standard error (0.318-0.405). The sensory attributes gave the following results; appearance (7.77- 8.07), aroma (7.20-8.63), taste (6.80- 8.23), mouth feel (6.87- 8.27), and overall acceptability (6.80- 8.33) and these results when interpreted on appoint hedonic scale. Higher scores generally indicated better sensory attributes and overall acceptability of the food formulation which was observed in sample CFB and CON. There were significant differences between most of the bread samples at (p< 0.05).

INTRODUCTION

Any nutritious solid, semisolid, or liquid food that babies eat in addition to breast milk or formula is considered complementary food (CF) (Okoronkwo *et al.*, 2023). When breast milk, which is traditionally the best and safest option for infants, is unable to meet the growing child's nutritional and energy needs, these foods are often offered between four and six months of age (Amagloh *et al.*, 2012). When a baby is breastfed, the World Health Organization (WHO) defines "complementary feeding practice" as the introduction of solid foods other than breast milk. Thin porridges or gruels are the most common preparations for complementary foods. Supplemental feeding may help babies *get all* the nutrients they need when breast milk is not enough.

According to Alemayehu *et al.* (2014), most infants require supplementary foods beyond breast milk to ensure adequate energy and nutrition for healthy growth, and this process starts at 6 months when the baby starts to move from exclusively breastfeeding to semi-solid foods. It continues until the baby is 24 months old. The only way to do this is to make sure the babies eat these meals in the right amounts and in a clean environment. The most important thing is to make sure that a child's dietary needs are met regardless of what they eat, absorb, and use. Infant malnutrition is mostly caused by a lack of skill in using the available basic ingredients, rather than the nation's economic state.

Among the world's most significant, adaptable, and underappreciated food crops is the sweet potato, scientifically known as *Ipomoea batatas* L. (Olatunde *et al.*, 2020). Subterranean sweet potatoes are rich in soluble carbohydrates, minerals, and vitamins; their flesh may be any shade from white to cream to yellow to purple to orange. The roots of sweet potatoes are a great source of nutrients and provide a wide range of sensory attributes due to their varied flavors, textures, and colors. Although sweet potatoes are rich in energy and other micronutrients like vitamin A, vitamin C, potassium, iron, and zinc, they are low in protein and fat. To make up for this, you can add legumes like soy beans to your sweet potato recipe to increase the protein content.

Products made from soybeans (*Glycine max* L.) are a great alternative to meat and dairy because they provide a variety of vitamins and minerals, as well as a "complete" protein profile that includes almost all of the necessary amino acids (with the exception of methionine). A growing number of people in sub-Saharan Africa are turning to soybean flour for its purported high protein, fat, and nutritional content (Mmari *et al.*, 2017). The food product's flavor and texture are just as important as its nutritional value and must be considered in meeting the needs of the target consumers. For these reasons, date palm fruit is an essential ingredient for sweeteners and nutritional enhancement of the acceptability of the food. Date palm fruit (*Phoenix dactylifera* L.) is a good source of

¹ Department of Chemistry, Faculty of Science, Benue State University, Center for Food Technology and Research, Makurdi, Nigeria

² Department of Food science and Technology Federal University of Agriculture, Makurdi, Benue State, Nigeria

³ Department of Food science and Technology, University of Mkar, Benue State Nigeria

* Corresponding author's e-mail: abuengmohpeter@gmail.com

sugar (around 70–80 % sugar content), depending on the species and maturity stage of the fruits and it is made of glucose, fructose, and sucrose which are easily absorbed by the body to provide energy (Abdul *et al.*, 2022). Date fruit contains a considerable amount of moisture (12–14), crude fiber (4.5–5.0), protein (2.0–2.5), fat (1.8–2.4), and ash (1.7–1.9) which is essential for children's growth and developments (Abdul *et al.*, 2022). Dates is also rich in antioxidants and phenolic compounds and also contain antimicrobial properties (Abdul *et al.*, 2022). This will help to improve the storage stability of the complimentary food formulations.

Statement of the Problem

Protein Energy Malnutrition (PEM)

PEM is a major nutritional problem especially in children and pregnant mothers in Sub-Saharan Africa. PEM is commonly caused by deficiency of protein in quantity and quality.

Micronutrient Deficiencies (MND)

MND is caused by insufficient supply of vitamins and minerals needed for growth, development and to maintain optimal health. MND can cause several serious health issues such as; lack of Iron, vitamin A, B12 and folic acid can lead to anemia causing fatigue, weakness, shortage of breath and dizziness.

Underutilization of Good Protein Sources from Crops

The growing global urge to switch from an animal-based protein diet to a vegetarian-based protein diet has accelerated the demand for the utilization of crops with high quality protein in the food industry. Under-utilized crops like soybeans can offer significant potential for food security, nutritional requirements.

Post-harvest Losses of Locally Available Crops

Locally accessible ingredients such as orange-flesh sweet potatoes are highly perishable, despite the fact that they are highly available and nutritionally rich hence converting them to flour and using to formulate complementary foods reduces post-harvest losses (Eucharia *et al.*, 2024).

Aim

The study aims to evaluate the quality of complementary foods produced from orange flesh sweet potato, soybean and date fruit flour blends

Specific Objectives

- i To determine the proximate composition complementary food formulations,
- ii. To determine rheological properties (viscosity versus Shear rate at 40°C) of gruels prepared from complementary food formulations
- iii. To determine the sensory attributes of gruels prepares from complementary food formulations

METHODOLOGY

The research used a combination of quantitative approach to determine the proximate composition (AOAC 2015) of food formulations and a qualitative approach to evaluate the rheological and sensory properties of gruels prepared from complementary food formulations.

Procurement of Materials

Sweet potato was obtained from the National Roots and Crops Research Institute (NRCRI), UMUDIKE. Soybeans, and dates palm fruits were obtained from the Wurukum Market, Makurdi. Nestle Cerelac was obtained from a local supermarket in Makurdi. Procured materials were taken to the CEFTER Food Processing Laboratory, Benue state university for processing.

Equipment

Standard equipment from the CEFTER food processing laboratory was used for the processing of the products. This equipment included but not limited to knives, bows, trays, driers, blender, mixer, oven, sieves (0.5 mm), measuring cylinder and weighing scale. Standard analytical equipment from the Chemistry laboratory were used for lab analysis.

Preparation of Raw Materials

Standard processing procedures and chemicals were used in the preparation of the flours and complementary food formulations.

Sweet Potato Flour

Mature orange-flesh sweet potato tubers (*Ipomoea batatas*), were cleaned and trimmed manually using knives. They were washed, peeled and sliced using a manual food slicer into smaller sizes of approximately 10 mm thickness to facilitate the drying process. The sliced sweet potatoes were blanched for 5 mins at 70°C and dried in an air circulating oven (Gallenkamp S/No 90/02/190, UK) at 60°C for 48 h according to the method of (Marcel *et al.*, 2021) with slight modification. The dried samples were milled to pass a 0.5 mm sieve for flour blends (Truong *et al.*, 2018).

Soybean Flour

Before being soaked for 24 hours, the soybean seeds were separated from large impurities like stone, sticks and rinsed. After the beans were soaked, they were strained through a sieve to remove any excess water. To make decortication easier and to inactivate the enzyme activity, the beans were cooked for 30 minutes. Robbing between palms was used to dehull the soybeans, and then potable water was used to drain off the skins. Afterwards, it was roasted for 30 minutes at 120°C after being oven dried for 48 hours in a hot-air oven. A laboratory mill (Laboratory Blender of type KM 901D; Kenwood Electronic, Hertfordshire, UK) was used to grind the roasted beans into flour. A 0.5 mm mesh sieve was used to filter the flour (Olatunde *et al.*, 2020).

Date Palm Flour

The date flour was prepared by sorting the date palm nuts to remove all foreign particles and washed. It was followed by de-seeding through manually cutting the nut using a knife and removing the seed. The inside was cleaned and size reduction of the nut was done in order to ensure efficient drying and milling processes. The pulp with the pericarp was then oven dried at 60°C for 72 h (Ahaotu *et al.*, 2021). The dried pulp was milled into fine flour using a laboratory blender. The flour was then sieved through a 0.5 mm mesh sieve (British Standard) to obtain fine homogeneous particle size flour and packaged.

Food Product and Diet Formulation

Table 1 displays the various amounts of orange-fleshed sweet potato flour, soybean flour, and date palm fruit flour that were combined to create different types of complementary food formulations. These flours were created from varying levels and percentages of flour replacement. Based on the protein content, these ratios

were determined to provide 16 g of protein per 100 g of food, in accordance with the recommendations made by the World Food Programme (2018) and the United Nations Children's Fund (2016) for baby meals. Based on the treatment combinations, five samples were produced using material balancing: CFA, CFB, CFC, CFD, and CFE. The diets were kept in 500 ml plastic containers with airtight lids and packed in low density dark-colored polyethylene bags. They were kept at room temperature with Nestle Cerelac used as the control.

Preparation of Porridges

Five composite flours (CFA, CFB, CFC, CFD & CFE) from different blends of orange-fleshed sweet potatoes, soybeans and date palm fruit (Table 1) and control sample (Nestle Cerelac) were used to prepare porridges by mixing 50 g of flour in 150 ml of water and boiled for 10 m with continuous stirring until the porridge is cooked (Marcel *et al.*, 2021).

Table 1: Sample Formulation of Complimentary Food

Samples	Orange-fleshed Sweet potato (%)	Soybean Flour (%)		Date (%)
		Boiled/Oven-dried	Sun-dried/Toasted	
CON	/	/	/	/
CFA	57.5	42.5	/	/
CFB	48	42	/	10
CFC	48	21	21	10
CFD	58	/	42	/
CFE	47.5	/	41.5	10

KEY

CON

Nestle Cerelac

CFA

Boiled and Oven-dried Soy Flour/Orange Fleshed Sweet Potato

CFB

Date palm, Boiled and Oven-dried Soy Flour/Orange Fleshed Sweet Potato

CFC

Date palm, Boiled and Oven-dried/Sun-dried and toasted Soy Flour/Orange Fleshed Sweet Potato

CFD

Non-Sweetened Sun-dried and toasted Soy Flour/Orange Fleshed Sweet Potato

CFE

Sweetened Sun-dried and toasted Soy Flour/Orange Fleshed Sweet Potato

Analysis

Proximate Composition of Complementary Food Samples

Using the analytical technique outlined in AOAC (2012) publication, the complementary foods were measured for moisture, protein, fat, ash, and crude fiber. The sum of the percentages of fat, moisture, ash, crude fiber, and protein content was subtracted from 100 to get the total carbohydrate.

Determination Rheological Properties (viscosity versus Shear rate) at 40°C

Gruels prepared from the complementary food samples were subjected to rheological studies by measurement of their viscosity using a viscometer. This was done at different share rates (5, 10, 20, 50 & 100 rpm) using spindle 4 at 40°C as described in the method used by (Okoronkwo *et al.*, 2023) with slight modifications. The relationship between viscosity and share rates at 40°C of gruels samples obtained from the complementary food formulations were investigated using Power law model described by (Ndombow *et al.*, 2024).

Sensory Evaluation of Porridges from Formulated Complementary Flour Blends

A panel of twenty (20) nursing mothers or caregivers from CEFTER, Benue State University, Makurdi who attended to children between 6 months and 2 years old were deployed to evaluate the coded gruels based on several sensory qualities. According to (Abuengmoh *et al.*, 2022), the panelists were given a 9-point hedonic scale to rate the samples based on their appearance, aroma, mouth feel, taste, and overall acceptability. A score of 1 indicates a strong dislike, 2 indicates a dislike, 3 indicates a moderate dislike, 4 indicates a slight dislike, 5 indicates neither a like nor a dislike, 6 indicates a slight like, 7 indicates a moderate like, 8 = a very much like, and 9 indicates an extreme like.

Statistical Analysis

The experiments were repeated three times and the

findings were analyzed using one way ANOVA. The Multiple Ranges Duncan's test ($p < 0.05$) using the statistical software of Statistical Package for the Social Sciences (SPSS), Version 28, was used to distinguish the groups. When applicable, we computed and reported means and standard deviations; we evaluated differences at the 95% significance level (Yakum *et al.*, 2024).

The rheological properties (relationship between viscosity and share rates) of gruel samples obtained from the complementary food formulations were analyzed using the power law model and results presented in table 3 (Ndombow *et al.*, 2024).

RESULTS AND DISCUSSION

Proximate Composition of Bread Samples from Wheat, Banana and Mango Flour Blends

The proximate compositions of samples were as shown in Table 2

Table 1: Sample Formulation of Complimentary Food

Samples	Moisture (%)	Ash (%)	Fiber (%)	Fat (%)	Protein (%)	CHO (%)
CON	2.51 ^d ±0.23	3.02 ^a ±0.36	4.22 ^a ±0.54	10.11 ^a ±0.31	15.12 ^b ±0.21	65.01 ^a ±0.04
CFA	7.38 ^a ±0.21	2.27 ^b ±0.13	2.11 ^c ±0.24	9.18 ^c ±0.25	16.00 ^a ±0.28	63.06 ^b ±0.67
CFB	6.84 ^b ±0.63	2.30 ^b ±0.16	2.35 ^b ±0.12	9.32 ^b ±0.16	16.03 ^a ±0.03	63.16 ^b ±0.01
CFC	6.64 ^b ±0.41	2.32 ^b ±0.21	2.37 ^b ±0.31	9.35 ^b ±0.32	16.11 ^a ±0.26	63.21 ^b ±0.53
CFD	7.04 ^{ab} ±0.15	2.31 ^b ±0.11	2.16 ^c ±0.43	9.13 ^c ±0.53	16.03 ^a ±0.18	63.33 ^b ±0.27
CFE	6.37 ^c ±0.17	2.32 ^b ±0.09	2.38 ^b ±0.23	9.27 ^b ±0.13	16.05 ^a ±0.29	63.61 ^b ±0.18

Values are means ± standard deviation of triplicate determinations. Mean scores within the columns with the same letters are not significantly different ($p > 0.05$). Key: CON, CFA, CFB, CFC, CFD, CFE same as in Table 1

Moisture Content of Complementary Food Formulations by Material Balancing

Moisture Content ranged from 2.51% in sample CON (Nestle Cerelac) to 7.38% sample CFA. There was significant ($p < 0.05$) reduction in moisture content from the samples without dates to the samples with date palm pulp flour. There was a more significant ($p < 0.05$) reduction in moisture content from all the other samples to sample CON. The addition of date palm pulp flour, led to a decrease in moisture content. This can be because of the ingredients in the food formulations and the way it was processed, specifically with regard to the soy bean flour. This conclusion is consistent with what was found in the study by Bello *et al.* (2020). The research found that the flour samples had a decreased moisture content, which means that the microbe activity would be lowered as well, extending the shelf life of the flour (Bello *et al.*, 2020). The FAO/WHO has advised a safe limit of less than 10% moisture for the complementary food formulations, since greater moisture levels might impact the food's storage quality.

Ash Content of Complementary Food Formulations by Material Balancing

The Ash Content of the complementary food formulations ranged from 2.27% in sample CFA to

3.02% in sample CON (Nestle Cerelac). The ash content increased insignificantly with addition of date palm pulp flour. This could be as a result of increased minerals in date palm pulp flour. Ash content is considered very essential as it gives a measure of the mineral elements that can be obtained from the food sample (Ashum Kumea, 2018). There was a significant ($p < 0.05$) increase in ash content from all the other samples to sample CON. The presence of milk in Nestle Cerelac accounts for the high ash content observed in that sample.

Crude Fiber Content of Complementary Food Formulations by Material Balancing

The crude fiber Content of the complementary food formulations ranged from 2.11% in sample CFA to 4.22% in sample CON (Nestle Cerelac). The crude fiber content increased insignificantly with addition of date palm pulp flour. The increase in crude fiber content observed from the addition of date palm pulp flour is a reflection of it being rich in roughage. Crude fiber content is considered very essential as it gives a measure of the bulk in the food sample (Ashum Kumea, 2018). There was a significant ($p < 0.05$) increase in crude fiber content from all the other samples to sample CON. The presence of maize in Nestle Cerelac accounts for the high crude fiber content observed in that sample.

Fat Content of Complementary Food Formulations by Material Balancing

The fat Content ranged from 9.13 % in sample CFD to 10.11% in sample CON. The fat content increased significantly ($p < 0.05$) with addition of date palm pulp flour. The increase in fat content observed from the addition of date palm pulp flour is a reflection of it being rich in fatty acids. Fat content is considered very important in food products as it gives a measure of the energy value of that food. It also influences oxidative rancidity of flours hence must be highly considered in food processing (Ashum Kumea, 2018). There was a significant ($p < 0.05$) increase in fat content from all the other samples to sample CON. The increased fat level detected in Nestle Cerelac is due to the milk powder that is in the sample. In general, the samples have a low fat content, which might be useful for storing flour samples. Bello *et al.* (2020) have made a similar finding. Due to the prevention of oxidative rancidity, these authors found that products with low quantities of fat had an extended shelf life.

Crude Protein Content of Complementary Food Formulations by Material Balancing

The crude protein Content ranged from 15.12 % in sample CON to 16.11% in sample CFC. The crude protein content increased insignificantly ($p < 0.05$) with addition of date palm pulp flour. The high amino acid content of date palm pulp flour explains why its addition raises the crude protein concentration. Consistent with previous research, this data suggests that the biochemical activities

of germinating seeds during malting are responsible for the higher protein content of the meal formulations (Bello *et al.*, 2020). From all the other samples to sample CON, the crude protein level decreased significantly ($P < 0.05$). Crude protein content is considered very important in food formulations because they make up the building blocks of the body hence playing a vital role in growth and repairs of damaged tissues.

Carbohydrate Content of Complementary Food Formulations by Material Balancing

The carbohydrate content of the complementary food formulations ranged from 63.06% in sample CFA to 65.01% in sample CON (Nestle Cerelac). The carbohydrate content increased insignificantly with addition of date palm pulp flour. This could be as a result of increased sugar in date palm pulp flour. carbohydrate content is considered very essential as it gives a measure of the mineral elements that can be obtained from the food sample (Ashum Kumea, 2018). There was a significant ($p < 0.05$) increase in carbohydrate content from all the other samples to sample CON. The presence of starch in maize and added sugar in Nestle Cerelac which are the building blocks of carbohydrates could account for the high carbohydrate content observed in that sample.

These measurements provided an understanding of the proximate composition of the different complementary food formulations. By comparing the moisture, ash, fiber, fat, protein, and carbohydrate content of each sample, we can assess their nutritional characteristics and make informed dietary evaluations.

Table 3: Rheological properties (viscosity versus Shear rate) at 40° C

Power Law Parameters	CON	CFA	Samples CFB	CFC	CFD	CFE
Intercept	5.227	4.568	4.506	4.508	4.562	4.519
$m(\text{Ns}^n/\text{m}^2)$	186.213	96.337	90.571	90.748	95.762	91.763
Slope	-0.589	-0.733	-0.730	-0.738	-0.732	-0.744
n	0.411	0.267	0.270	0.262	0.267	0.256
r^2	0.993	0.989	0.986	0.984	0.990	0.977
S.E	0.318	0.397	0.396	0.401	0.396	0.405

Key: m : consistency index, n : Flow behavior index, r^2 : Coefficient of regression

S.E: Standard error, CON, CFA, CFB, CFC, CFD, CFE same as in Table 1

Rheological Properties (viscosity versus Shear rate) at 40°C of Gruel Samples Using the Power Law Model

The relationship between viscosity and share rates at 40°C of gruel samples obtained from the complementary food formulations were investigated using Power law model and results presented in table 3.

Consistency Index (m) of Complementary Food Formulations

At 40°C, consistency index (m) of the various complementary food formulations ranged between 90.57 Ns^n/m^2 in sample CFB made of boiled and oven-dried

soy flour/orange-fleshed sweet potato to 186.21 Ns^n/m^2 in sample CON. The samples with date palm pulp flour had a significantly ($p < 0.05$) low consistency index from the samples that had only soy bean flour and orange-fleshed sweet potato flour. There was an increase in the consistency index for complementary food formulations without date palm pulp flour. This implies that the introduction of date palm pulp flour to the complementary food formulations decreased the consistency index of the food formulation. Sample CON had a significant ($p < 0.05$) difference from the other samples and had a high consistency index. The consistency index values were related to the viscosity.

Flow behavior Index (n) of Complementary Food Formulations

At 40°C, Flow behavior index (n) were all $n < 1$. The flow behavior index (n) of the various complementary food formulations ranged between 0.256 in sample CFE to 0.411 in sample CON. There was no significant ($p < 0.05$) difference in flow behavior index (n) amongst the complementary food formulations except sample CON. Sample CON had a significant ($p < 0.05$) difference from all the other samples and had a high flow behavior index (n). This is surely due to the fact that it is composed of maize which gelatinised to make it very thick hence significantly increasing the flow behavior index of that sample. For all the samples, flow behavior index (n) is less than 1 ($n < 1$), inferring that it is a pseudoplastic fluid. Pseudoplastic fluids are those fluids whose behavior are time independent and have a lower viscosity at higher shear rates and produce less resistance. The flow behavior index provided information about the effect of shear rate on the fluid. This is similar to the work done by (Perrechil *et al.*, 2010) on commercial Italian salad dressings.

Coefficient of Regression (r^2) of Complementary Food Formulations

Coefficient of regression (r^2) determines the proportion of variance in the dependent variable that can be explained by the independent variable. At 40°C, the coefficient of regression (r^2) of the various complementary food formulations ranged from 0.9765 in sample CFE to 0.9928 in sample CON (Nestle Cerelac). There was no significant ($p < 0.05$) difference in the coefficient of regression amongst the complementary food formulations. They

were all approximately 1. This implies that the coefficient of regression in this model predicts almost a 100 % relationship between the dependent and independent variables. For this study, coefficient of regression ranges from 0.9765 for sample CFE to 0.9928 for commercial Nestle Cerelac, which means that the model predicted 97% of the relationship between viscosity and shear rates for sample CFE while for commercial Nestle Cerelac, it predicted 99% of relationship between viscosity and shear rates

Standard Error (S.E) of Complementary Food Formulations

At 40°C, the Standard error of the various complementary food formulations ranged from 0.318 in sample CON to 0.405 in sample CFE. There was no significant ($p < 0.05$) difference in Standard error amongst the complementary food formulations except sample CON made of Nestle Cerelac. Sample CON had a significant ($p < 0.05$) difference from all the other samples and had a low Standard error.

The consistency index values were related to the viscosity and the flow behavior index provided information about the effect of shear rate on the fluid (Perrechil *et al.*, 2010). For instance, when the gruel is forced out through pipes, it flows out smoothly from the pipe due to the low viscosity at high flow rate. However, after it is poured out, it does not flow and its increased viscosity allows it to be rigid. This information is important to consider in the food industry when transferring fluid foods through pipes or the choice of the size of pipe to use for packaging.

Table 4: Sensory Evaluation of complementary food formulations

Samples	Appearance	Aroma	Taste	Mouth Feel	Overall Acceptability
CON	8.07 ^a ±0.83	8.63 ^a ±0.61	8.20 ^a ±0.61	8.20 ^a ±0.61	8.33 ^a ±0.61
CFA	7.77 ^d ±1.07	6.77 ^c ±0.94	6.87 ^d ±1.01	6.87 ^d ±0.86	6.80 ^d ±1.03
CFB	7.93 ^b ±1.07	7.93 ^b ±0.74	8.23 ^a ±0.94	8.27 ^a ±0.87	8.27 ^a ±0.83
CFC	7.83 ^c ±0.91	7.80 ^c ±0.76	7.90 ^b ±0.85	7.67 ^b ±0.66	7.53 ^b ±0.78
CFD	7.73 ^d ±0.98	7.50 ^d ±1.01	7.47 ^c ±0.73	7.23 ^c ±0.68	7.03 ^c ±0.76
CFE	7.80 ^c ±1.20	7.20 ^e ±1.10	6.80 ^d ±0.89	6.87 ^d ±0.86	6.73 ^d ±0.91

Values are means ± standard deviation of triplicate determinations. Mean scores within the columns with the same letters are not significantly different ($p > 0.05$). Key: CON, CFA, CFB, CFC, CFD, CFE same as in Table 1

Sensory Evaluation of Complementary Food Formulations

The sensory scores of the gruels prepared from both the control and formulated samples showed significant ($p < 0.05$) differences in appearance, aroma, taste, mouth feel and overall acceptability.

Appearance Scores of Complementary Food Formulations

The appearance scores of the complementary food formulations ranged between 7.77 in sample CFA to 8.07 in sample CON. The samples with date palm pulp flour had

a chocolate brown appearance and was preferred by many panelists hence showed a significant ($p < 0.05$) difference from the samples that had only soy bean flour and orange-fleshed sweet potato flour. Sample CON (Nestle Cerelac) had a cream white appearance and was the most preferred by sensory panelists. There was a significant ($p < 0.05$) difference between sample CON and all the other samples.

Aroma Scores of Complementary Food Formulations

The aroma of the various complementary food formulations ranged between 7.20 in sample CFE to 8.63 in sample CON. The samples with date palm pulp

flour had a significant ($p < 0.05$) difference in aroma from the samples that had only soy bean flour and orange-fleshed sweet potato flour. This was with the exception of sample CFE that recorded the lowest score in aroma. This implies that the introduction of date palm pulp flour to the complementary food formulations brought in some flavor components that enhanced the aroma of the food formulation. The increase in aroma is of great significance, as it is reported to increase the acceptability of the food formulation to infants. In a similar work carried out by (Bello *et al.*, 2020). In general, consumers tend to dislike the smell of soy beans, according to Bello *et al.*, (2020). Therefore, it is possible that the inclusion of OFSP and date contributes to the higher scent scores of the food formulation types. Because OFSP and dates have stronger and more appetizing flavors, they might have made the food formulation types more palatable by masking the smell of iron-rich soy beans. This confirms the results of an Ethiopian study on composite porridge (Adoko *et al.*, 2021) that included sweet potato, soybean, and moringa.

Taste Scores of Complementary Food Formulations

The taste scores of the complementary food formulations ranged between 6.80 in sample CFE to 8.23 in sample CFB. There was no significant ($p < 0.05$) difference between sample CON and sample CFB but these samples were significant ($p < 0.05$) different from the other samples. The samples with date palm pulp flour also had an insignificant enhanced taste score from the samples that had only soy bean flour and orange-fleshed sweet potato flour. Thus the higher scores for the taste of the complementary food formulations compared to the control could be attributed to the relatively high sugar content due to inclusion of OFSP, date (Adoko *et al.*, 2021) and the associated chemical processes following their production. The result which shows a significantly higher score in terms of overall acceptability for the complementary food formulations is in agreement with the outcome of investigations conducted by (Adoko *et al.*, 2021) which showed high overall acceptability of complementary processed food formulated using OFSP and common beans. This indeed provides additional evidence illustrating the contribution of OFSP to the positive sensory attributes of nutritionally enhanced products observed in the current study.

Mouth Feels Scores of Complementary Food Formulations

When it comes to determining whether or not designed meals are acceptable, tongue feel is a key metric. The supplemental meal formulations had mouth feel values ranging from 6.87 in the CFA/CFE sample to 8.27 in the CFB sample. These samples were significantly different from the others, although there was no significant difference ($p < 0.05$) between sample CON and sample CFB. The greater levels of fiber in OFSP and Date flour may explain why sample CFB had a better mouth feel than Nestle Cerelac (sample CON) (Kotue *et al.*, 2021). A study

found that dietary fiber made food items feel softer in the mouth, which led researchers to draw this conclusion.

Overall Acceptability Scores of Complementary Food Formulations

In the CFA sample, the average score for overall acceptability was 6.80, whereas in the CON group, it was 8.33. The panelists' overall assessment of the complementing meals was conveyed in this way. It was shown that the supplementary meals' overall acceptance was most affected by their appearance, aroma, taste, and mouth feel. With an average score of 8.33, the panelists found the control sample to be the most palatable, followed closely by the CFB sample, which consisted of date paste, boiling sweet potato, and oven-dried soy flour. Although sample CON and sample CFB were not significantly different from one other ($p < 0.05$), there was a significant difference between the two samples. In comparison to the samples that included just soy bean flour and orange-fleshed sweet potato flour, the ones that contained date palm pulp flour showed a significant ($p < 0.05$) difference. It may be inferred that the addition of date palm pulp flour to the supplementary food recipes enhanced their sweetness and flavor. Because it is said to make babies more receptive, the sweetness boost is quite important. The sensory aspects of supplementary food formulations, which are strongly tied to newborn and early child food preferences, are more important than their energy density, according to a paper by Bello *et al.* (2020). This proved that while developing and assessing the quality features of homemade supplemental food formulations, sensory assessment deserves sufficient consideration.

Sensory attributes depend largely on the nature of various ingredients used in the formulation, the blending ratios and the processing methods applied (Okoye *et al.*, 2021)

CONCLUSION

Acceptable complimentary food can be produced from sweet potatoes, soybean flour and date fruit using an optimum level of 48% OFSP, 42 % boiled and oven-dried soy flour and 10% date flour (sample CFB). The formulated samples improved the proximate properties of complementary foods and thus improved the overall nutritional profile of food. There was no significant difference between most of the formulation samples at ($p < 0.05$) except for the control sample. This was because all the experimental food samples were formulated to 16g protein per 100g of complementary food samples.

The flow behavior index (n) of the gruels exhibits $n < 1$ indicating pseudoplastic behavior, a characteristic of non Newtonian fluids. This information is important to consider in the food industry when transferring fluid foods through pipes or the choice of the size of pipe to use in the process.

The gruel samples were generally accepted by the panelists with sample containing 48% OFSP, 42 % boiled and oven-dried soy flour and 10% date flour (CFB) being the most

preferred. The processing techniques, blending ratios, and constituent types utilized in the formulation significantly impact the sensory difference.

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