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Evaluation of Sensory Attributes of Complementary Meals made from Malted Yellow Maize (*Zea mays* L.) and Sprouted Cowpea (*Vigna unguiculata*) Flour Blends available in South Western Nigeria

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ABSTRACT: The need to measure, analyze and interpret the reactions of people to complementary food products as perceived by their senses is important. This will provide valid and reliable information to the research, production and marketing departments in order for the management team to make sound business decisions about the perceived sensory properties of the complementary food product(s). This study evaluated the sensory attributes of complementary meals made from malted yellow maize (*Zea mays* L.) and sprouted cowpea (*Vigna unguiculata*) flour blends using standard methods on a 5-point hedonic scale ratings with 105 trained adult female evaluators. The mean scores ranges sensory evaluation attributes were appearance (3.58 to 4.24), taste (3.58 to 4.34), consistency (3.76 to 4.04), smell (3.47 to 4.12) and overall acceptability (3.31 to 4.20) of produced complementary food. ANOVA revealed a significant difference ($p < 0.05$) in the appearance ($F = 8.82$), taste ($F = 10.24$), smell ($F = 6.53$) and overall acceptability ($F = 8.19$) of the complementary food produced. The study concluded that the diets prepared from the sample with 20% sprouted cowpea and 80% malted yellow maize flours substitution had better acceptability than the other test samples. Therefore, the need to exploit the positive attributes of quality cowpea and yellow maize without compromising its general acceptability as this will at the end, contribute to the improvement of health and nutrition right from childhood.

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The World Health Organization recommended that exclusive breastfeeding be extended from four to six months of age to a full six months (Giugliani, 2019). Breast milk contains all of the nutrients that newborns require to develop and be healthy (Kim and Yi, 2020). However, after this period, it may be insufficient to provide the nutritional needs of developing newborns. As a result, there is a need to supplement breast milk with other foods that can assist reduce any deficiencies caused by such insufficiency (van Spronsen, et al., 2021). Any food that is suitable as a complement to breast milk or as a breast milk substitute, when either becomes insufficient to meet the nutritional needs of the infant, is considered a complementary food (WHO, 2018). Traditional supplementary meals have been observed to be severely insufficient in Nigeria, as in most other poor nations, when compared to predicted needs. In Nigeria, the most common supplemental meal for newborns is fermented cereal gruel, which mothers find to be easily digestible (Oke, et al., 2022). However, this has been observed to be low in specific nutrients necessary for newborn growth and has been linked to the prevalence of malnutrition in impoverished nations. In Nigeria, there has been a lot

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of interest in the formulation and creation of nutritious supplemental meals using locally and easily available basic ingredients (Dutta and Sharma, 2020). This has added a lot of variety to Nigeria's traditional supplemental meals. Nevertheless, like all cereals, the common maize used in the production of traditional complementary foods has two significant flaws. It is low in protein and does not supply enough critical amino acids (lysine and tryptophan) to suit the nutritional needs of newborns. As a result, in terms of protein quality, the ordinary maize variety is deficient. High in protein, carbohydrates, ash, and other nutrients, cowpea, a common legume in Nigeria, will undoubtedly provide a complementary food that can significantly lower the rate of malnutrition, which has been linked to increased infant death and disease rates in the African continent (Alfa, et al., 2020). Regular use of well-formulated supplementary food has been shown to improve the nutritional condition of kids under the age of in Low and Middle-Income Countries (Dimaria et al., 2018). Traditionally developed transformed cereal-based blends are typically made from cereal grains or starchy grain base raw food materials to which various sources of amino acids and fatty acids, primarily pulses, but additionally fish that has been dried or powdered dairy products, vitamins and minerals premix, and various other elements are incorporated to enhance the diet's nutritional content and flavour (Offiah et al., 2019). Traditionally developed manufactured cereal-based blends might better match the organoleptic and sociocultural standards if made with locally cultivated basic ingredients (Sellers et al., 2019). These would have a positive impact on the domestic economy, notably by creating jobs and adding value to indigenous raw food material resources (Materia et al., 2021; 2022). As a result, it is more important than ever to produce cheap, nutrient-dense supplemental meals that match the criteria for baby and early child dietary variety. To do this, complementary meals may be created utilizing locally grown food crops that are both economical and readily available, as well as animal protein that is already a staple of the diet. By combining composite flour from malted yellow maize (*Zea mays* L.) with sprouted cowpeas (*Vigna unguiculata*), this study will shed light on the sensory characteristics of the complementary meal. As a result, the objective of this study is to present the evaluation of sensory attributes of complementary meals made from malted yellow maize (*Zea mays* L.) and sprouted cowpea (*Vigna unguiculata*) flour blends available in South Western Nigeria..

MATERIALS AND METHODS

Materials: Cowpeas (*Vigna unguiculata*) and maize (*Zea mays* L.) were sourced at neighborhood markets in the South-West of Nigeria. Five complementary meal blends were produced for this study by combining certain staples and protein supplements. In equal amounts, a mild, sweet fish taste and a sweetener made from root vegetables were added to the prepared foods as sources of energy and to enhance their flavor and texture.

Production of Malted Maize Flour: In accordance to Olaoye et al., (2015), clean water was used to wash the whole grains of yellow maize after they had been processed to eliminate debris and other impurities. After an hour of soaking, the grains were emptied. They were placed on jute bags, watered, and let 48 to 72 hours to germinate. The radicules and plumules were then eliminated by winnowing after the germinated grains were dried at 65°C for 24-36 hours in an air drying oven. The malted yellow maize flour was then produced by milling it in a hammer mill and sieving it. Before usage, the flour samples were kept at room temperature in polyvinyl chloride bags.

Production of germinated cowpea flour: In order to soak for eight hours at room temperature, cowpeas were first cleaned under cold running water following the procedure of Hallén, et al, (2004). The moistened seeds were spread out on trays wrapped with aluminum foil and lined with damp, previously sterile muslin sheets. In an incubator set at 25 °C, germination continued for three days. Formed roots and testa were then wiped off after being dried at 50 °C for three days. Seeds that had been dried and sprouted were pulverized through a 1 mm mesh screen. Before usage, the flour samples were kept at room temperature in polyvinyl chloride bags.

*Experimental design***:** Complementary diets were created to satisfy the nutrient needs of infants and toddlers between the ages of 6 and 24 months (Samuel et al., 2021). For the first four to six months, a newborn should receive 96 kcal/kg of calories daily in addition to breast milk (Isanaka et al., 2020). The daily need for protein is 14 grams to 15.5 grams of a quality comparable to that found in milk or eggs (Hofvander and Underwood, 1987; Campoy et al., 2018). The processed flours were used to formulate composite diets in the ration of different proportions. Malted yellow maize flour and sprouted beans flour had different percentage combination in the diets. These composite flour was blended to formulate five different diets of different compositions of complementary food ingredients. The blends is as indicated in Table 1. Sprouted cowpea beans and malted yellow maize flour was mixed thoroughly in different ratios in a rotary mixer to produce homogenous complementary food formulations. The

complementary foods formulated was separately packaged in airtight plastic containers and preserved in a freezer until needed for analyses. Below is a list of the formulation's compositions.

Table 1. Formulation of complementary food

Formulations	Percentage	
	Sprouted Beans	Sprouted Yellow Maize
MC8020	20	80
MC1000	0	100
MC9010	10	90
MC6040	40	60
MC7030	30	70
Range	0-40	60-100

Sensual examination of complementary meal combinations: The sensory evaluation of the five designed complementary meal combinations was conducted using a five point hedonic scale after they had been made into porridges. These ranged between disliked extremely (1) and liked extremely (5). A total of 105 trained evaluators (adult females) who were students from tertiary institutions in three states (35 adult female trained evaluators each from Oyo, Osun and Ogun States) in South West, Nigeria were used in this study. In order to maximize the capacity to unbiasedly assess the sensory qualities of the compositions, mature female evaluators were used in place of the intended users, children under the age of 24 months (Mkenya et al., 2013).

Statistical Evaluation of Analytical Data: The results was expressed as means were tested for significant differences using one-way analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

The results of sensory evaluation by the evaluators is presented in Table 2. The outcome revealed a fair amount of similarity among the prepared complementary foods. The average score points for the characteristics under consideration were that of appearance (3.58 - 4.24), taste (3.58 - 4.34), consistency (3.76 - 4.04), smell (3.47 - 4.12), and overall acceptability (3.31 - 4.20). Diet acceptability and decision are influenced by attractiveness. The results of the sensory examination showed that while some of the samples had comparable appearances, others had substantial differences. The evaluators considerably (statistically significant at less than 0.05) rated formulations MC9010 and MC6040 better than the remaining tested recipes, with the exception of composition MC8020. For the formulations MC9010, MC8020, and MC6040, the average ratings were 4.20, 4.24, and 3.94, correspondingly. The majority of the formulations scored over 3.0 points, with the exclusion of MC9010, MC8020, and MC6040, showing that most of the composite blends were, on the usual, pleasant based on the look of the diets to the evaluators. When analyzing a food's sensory quality, flavor is a key factor. Even though the product is attractive and has an elevated density of energy, it is unlikely to be accepted if it lacks good palate. The evaluators gave formulation MC8020 considerably (statistically significant at less than 0.05) better taste ratings than the remainder of the tested formulations, with the exception of formulation MC9010. The average ratings for MC8020 formulation and MC9010 formulation were 4.34 and 4.20, respectively. The majority of the developed blends received scores over 3.0 points, with only the case of compositions MC9010 and MC8020, showing that the evaluators generally liked the flavor of the diets in most of the newly developed blends. The nutritional density and, consequently, the amount of feed that the child may ingest each meal are both influenced by the consistent nature of supplementary meals. First, the consistent nature of complementary foods should be adequate for the child's phase of neuromuscular development. Nonetheless, evaluators' evaluations of consistency found no significant differences (statistically not significant at less than 0.05) between any of the sample-formulated diets. The majority of the formulated blends had grades over 3.0 points, suggesting that they were generally liked by the evaluators based on the consistent nature of the diets. Prior to eating, aroma has a key role in flavor and the general enjoyment of the meal. As a result, it plays a crucial role in determining whether or not developed meals are acceptable. The findings of the sensory analysis showed that the fragrance of certain samples differed considerably (statistically significant at less than 0.05) from that of the rest. In general, the scent score points of MC9010, MC8020, and MC6040 were considerably (statistically significant at less than 0.05) better than those of the other formulations chosen by evaluators. The majority of the prepared blends were, on regular, liked by the evaluators based on the scent of the diets, except for preparations MC9010, MC8020, and MC6040. The rest of the preparations scored over 3.0 points.

In all, evaluators gave the designed supplementary meals MC9010, MC8020, and MC6040 extremely favorable ratings, with the average score ratings of 4.09, 4.20, and 4.07 correspondingly. In comparison to the other samples, their acceptance score ratings were substantially greater (statistically significant at less than 0.05). Except for formulations MC9010, MC8020, and MC6040, the remainder of the formulations had scores over 3.0 points, suggesting that the evaluators generally liked most of the designed food blends. However, the ANOVA revealed

a significant difference (statistically significant at less than 0.05) in the appearance (F = 8.82), overall acceptability (F = 8.19), smell (F = 6.53) and taste (F = 10.24) of the complementary food produced. On the contrary, there was an insignificant difference (statistically not significant at less than 0.05) in the texture (F = 1.41) of the complementary food produced.

Table 2. Sensory evaluation of complementary food produced

Formulations	Appearance	Taste	Texture	Smell	Overall Acceptability
MC8020	4.24^{a}	4.34^{a}	3.96^{a}	4.12^{a}	4.20^{a}
MC1000	3.58^{c}	3.77^{cd}	3.76^{a}	3.53^{d}	3.31^{c}
MC9010	4.20^{a}	4.20^{ab}	4.04^{a}	4.12^{a}	4.09^{a}
MC6040	3.94^{ab}	3.99^{b}	3.99^{a}	3.95^{ab}	4.07^{a}
MC7030	3.63^{c}	3.58^{cd}	3.79^{a}	3.47^{d}	3.46^{bc}
F-value	8.82**	10.24**	1.14	6.53**	8.19**

*Column values of different superscripts are significantly different @ ** = p < 0.05)*

Conclusions: Cowpea and yellow maize are cheap and readily available food ingredients that can be used by nursing mothers and care givers to supplement traditional complementary foods in Nigeria and other developing countries of the world in order to reduce the problem of protein-energy malnutrition among infants and young children due to their high nutrient density. It is therefore interesting to state that the positive attributes of cowpea and yellow maize need to be exploited without compromising the general acceptability. This will in the end contribute to improvement of health and nutrition right from childhood.

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