EFFECT OF MALTING ON PROXIMATE COMPOSITION AND SENSORY PROPERTIES OF GRUEL MADE FROM MALTED WHEAT, RICE, GROUNDNUT, SESAME, AND CARROT BLENDS

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Abstract

This study investigated the effect of malting on the proximate composition and sensory attributes of a multi-ingredient gruel formulated from wheat, rice, groundnut, sesame, and dried carrot. Four different formulations (A, B, C, D) with varying proportions of each raw materials were analyzed in both malted (A^I, B^I, C^I, D^I) and unmalted forms. Proximate and sensory analyses were carried out on the samples. Proximate results revealed significant changes ($p < 0.05$) in moisture, ash, crude fat, crude protein, crude fiber, total carbohydrate, and energy content due to malting. Malted samples exhibited reduced moisture (4.96–7.07%) and crude fat (4.95–5.60%) but increased ash (3.85–4.20%), crude protein (10.98–12.33%), and crude fiber (7.62–9.48%). Total carbohydrate remained high (63.87–65.52%), while energy content decreased (350.35–355.28 kcal) compared to unmalted samples. Sample C^I is highly rated by the panelist with overall acceptability of 8.7 ± 0.3. These findings suggest that malting improves protein and fiber content while reducing fat, making the gruel more nutritionally balanced.

Keywords: *Malting, proximate composition, gruel, nutritional enhancement, functional food*

Introduction

Malting is a controlled biotechnological process of germination, that triggers endogenous enzymes to enhance the nutritional and functional properties of cereals by modifying macro nutrients (carbohydrates and proteins) (Briggs, 1998). Malted grains are known to improve digestibility, increase nutrient bioavailability and enhance flavor (Blandino *et al*., 2003), a sensory attribute that significantly influence consumer acceptance of any food product, (Stone and Sidel, 2004). Wheat (*Triticum aestivum*) is commonly malted to improve its digestion and makes the nutrients readily availability for absorption (Kaur *et al*., 2014). The chosen ingredient has a range of nutrient essential especially for infant developmental stages, such as carbohydrates from white rice and wheat, healthy fats from sesame and groundnut and crucial vitamin and mineral from carrots, aiming to provide comprehensive and nutrient dense diet that aligns with the dietary requirement of infants and adults as well. Gruel, a semi-liquid food made from cereals and legumes, is often fortified with additional ingredients to enhance its nutritional and sensory properties.

Gruels made from composite flours are widely consumed as complementary foods and energy-dense supplements however, their nutritional quality can be further improved through malting (Adebiyi *et al*., 2016). This study evaluated the effect of wheat malting on the proximate composition and sensory attribute of a multi-ingredient gruel containing rice (*Oryza sativa*), groundnut (*Arachis hypogaea*), sesame (*Sesamum indicum*), and carrot (*Daucus carota*) to compare with unmalted samples for macronutrient balance.

Materials and Methods

Source of Raw Material

The ingredient consisting of wheat, rice, groundnut and sesame were obtained from wudil market and the carrot from *yankaba* market of Kano State, Nigeria. The materials were was transported to the laboratory of food science and technology, Aliko Dangote University of Science and Technology, for processing and the processed sample were taken to food analysis laboratory for analysis in a clean polyethylene bag.

Equipment's and Reagents

The equipment, apparatus and reagents used in the analysis were: Weighing balance, Hot air oven, Petri-dish, measuring cylinder, Filter paper, Beakers, Test tubes, Pipette, Muffle furnaces, Plastic container, Spatula, Crucibles, Burette, Alcohol, 40% Noah, 15ml Sulphuric acid, 5g kjeldhal tablet, methyl orange, methanol, boric acid.

Sample Preparation

Wheat malting

First, the wheat was steeped in water to increase the moisture content to about 45%, to initiate germination through hydration and aeration. The grain germinated within the period of two days at room temperatures with gentle, regular turning to ensure modification without rootlet matting. Finally, the germinated wheat grains were kilned.
(Kunze, 2019)

Preparation of the blend

The rice, groundnut and sesame were cleaned by winnowing and aspiration to remove foreign and light material present. Carrots were washed with cool water, cut into small pieces and then allowed to dry for three days in the laboratory; other ingredients (malted wheat, rice, groundnut, and sesame) were added and then milled into flour.
Formulations: Four gruel samples (A, B, C, D) were prepared with varying wheat-rice ratios (Table 1). Malted variants (A^I, B^I, C^I, D^I) contained malted wheat.

Table 1: The percentage composition of each sample: the superscripts (I) indicate malted wheat

Sample	Wheat (%)	Rice (%)	Groundnut (%)	Sesame (%)	Carrot (%)
A	45	45	4	4	2
A^I	45	45	4	4	2
B	50	40	5	3	2
B^I	50	40	5	3	2
C	60	30	5	4	1
C^I	60	30	5	4	1
D	65	25	5	4	1
D^I	65	25	5	4	1

Proximate Analysis

AOAC (2016) Methods of analysis were followed to determine moisture, ash, crude protein, crude fat and crude fiber while total carbohydrate was determined by difference. Energy values were calculated using Atwater factors.

Gruel Preparation

Briefly the gruel is prepared using ratio of 1:4 (flour to water), by combining the gruel flour with liquid in a pot simmering the mixture while stirring frequently until the grains break down and soften. Cooking until it reaches a thin, soupy consistency.

Sensory Evaluation

A nine-point Hedonic Scale questionnaire was used for the test, and thirty (30) semi-trained panelists were used to assess the samples.

Statistical Analysis

Data were analyzed using ANOVA (SPSS v20), and means were separated by Duncan's test ($p < 0.05$).

Results and Discussion

The proximate composition of food products is essential in determining their nutritional quality, energy content, and potential health benefits (Osundahunsi *et al*., 2007). The results from Table 2 reveal significant variations ($p < 0.05$) in the moisture, ash, crude fiber, crude fat, crude protein, total carbohydrate, and energy content among the different gruel formulations.

The moisture content was significantly higher in non-malted samples (A: 10.79%, B: 11.40%, C: 11.79%, D: 11.85%) compared to the malted sample at the same percentage of the formulations (A^I: 7.07%, B^I: 6.72%, C^I: 5.28%, D^I: 4.96%). This reduction in moisture of malted samples can be attributed to the drying process during malting, which decreases water activity and enhances shelf stability (Blandino *et al*., 2003). Lower moisture content in malted flours is advantageous for storage and reduces microbial spoilage (Adebiyi *et al*., 2016). Malted samples exhibited significantly higher ash content (A^I: 3.91%, B^I: 4.08%, C^I: 4.20%, D^I: 3.85%) compared to non-malted samples (A: 0.77%, B: 0.74%, C: 0.75%, D: 0.60%). This suggests that malting enhances mineral retention, possibly due to enzymatic breakdown of phytates, which typically bind minerals (Olagunju *et al*., 2018). The higher ash content in malted samples indicates a richer mineral profile, which is beneficial for micronutrient supplementation (Udensi *et al*., 2008). Crude fiber content was higher in malted samples (A^I: 7.62%, B^I: 8.04%, C^I: 9.03%, D^I: 9.48%) compared to non-malted samples (A: 7.63%, B: 7.28%, C: 7.36%, D: 7.45%). The increase in fiber may result from the partial breakdown of starch and non-starch polysaccharides during malting, releasing more dietary fiber (Bamforth, 2009). Dietary fiber is crucial for digestive health and may help in managing blood glucose levels (Dhingra *et al*., 2012). Non-malted samples had significantly higher fat content (A: 13.22%, B: 15.61%, C: 16.80%, D: 18.27%) than malted samples (A^I: 4.95%, B^I: 4.99%, C^I: 5.56%, D^I: 5.60%). This reduction could be due to lipase activity during malting, which hydrolyzes fats into free fatty acids (Adebiyi et al., 2016). While fat contributes to energy density, excessive fat oxidation can lead to rancidity, making malted samples more stable (Olagunju et al., 2018). Malted samples showed significantly higher protein content (A^I: 10.98%, B^I: 11.34%, C^I: 12.06%, D^I: 12.33%) compared to non-malted samples (A: 3.82%, B: 6.67%, C: 6.22%, D: 6.42%). This increase may be due to protease activation during malting, which breaks down storage proteins into more digestible forms (Bamforth, 2009). Higher protein content enhances the nutritional value, particularly for children and protein-deficient populations (Udensi et al., 2008). Non-malted samples had slightly lower carbohydrate content (A: 63.94%, B: 58.27%, C: 57.06%, D: 55.45%) compared to malted samples (A^I: 65.52%, B^I: 65.02%, C^I: 63.87%, D^I: 63.89%). However, the energy content was higher in non-malted samples (A: 390.02 kcal, B: 390.25 kcal, C:

404.32 kcal, D: 411.91 kcal) than malted samples (A^I: 350.55 kcal, B^I: 350.35 kcal, C^I: 353.76 kcal, D^I: 355.28 kcal), likely due to their higher fat content.

The sensory evaluation results (Table 3) indicate significant differences ($p < 0.05$) in taste, color, aroma, texture, and overall acceptability among the samples. Sample $\mathbf{C^I}$ (malted wheat 60%, rice 30%, groundnut 5%, sesame 4%, carrot 1%) received the highest scores in all sensory attributes (8.5 ± 0.3 for taste, 8.3 ± 0.2 for color, 8.4 ± 0.1 for aroma, 8.6 ± 0.2 for texture, and 8.7 ± 0.3 for overall acceptability). This suggests that malted grains positively influence the sensory properties of gruel, likely due to enhanced sweetness and reduced bitterness from enzymatic activity during malting (Bamforth, 2009). In contrast, sample $\mathbf{D^I}$ (malted wheat 65%, rice 25%, groundnut 5%, sesame 4%, carrot 1%) scored the lowest (6.0 ± 0.2 for taste, 6.2 ± 0.1 for color, 6.3 ± 0.3 for aroma, 6.7 ± 0.1 for texture, and 6.5 ± 0.2 for overall acceptability). This may be due to an imbalance in ingredient ratios, leading to unfavorable sensory characteristics. Non-malted samples (A, B, C, D) generally performed moderately, with sample **D** (wheat 65%, rice 25%, groundnut 5%, sesame 4%, carrot 1%) scoring highest among them (8.50 ± 0.67 for taste, 8.10 ± 0.99 for color, 8.05 ± 0.97 for aroma, 7.80 ± 1.16 for texture, and 8.25 ± 0.82 for overall acceptability). The findings align with previous studies indicating that malted cereal-based foods exhibit improved sensory profiles compared to their non-malted counterparts (Olagunju et al., 2018). The superior performance of sample $\mathbf{C^I}$ suggests that a balanced ratio of malted wheat and rice, along with appropriate fortification, enhances gruel acceptability.

Table 2 Proximate composition of the composite flour of the gruel formulated

Sample	Moisture (%)	Ash (%)	Crude Fiber (%)	Crude Fat (%)	Crude Protein (%)	Total Carbohydrate (%)	Energy (kcal)
A	$10.79{\pm}0.06^a$	$0.77{\pm}0.01^b$	$7.63{\pm}0.1^a$	$13.22{\pm}0.02^a$	$3.82{\pm}0.1^c$	$63.94{\pm}0.91^a$	390.02
A^I	7.07 ± 0.01^b	$3.91{\pm}0.01^a$	$7.62{\pm}0.03^d$	4.95 ± 0.01^d	$10.98{\pm}0.02^a$	65.52 ± 0.05^a	350.55
B	$11.40{\pm}0.05^a$	$0.74{\pm}0.06^b$	$7.28{\pm}0.2^b$	$15.61{\pm}0.56^b$	$6.67{\pm}0.01^b$	$58.27{\pm}0.24^b$	390.25
B^I	6.72 ± 0.02^b	$4.08{\pm}0.01^a$	$8.04{\pm}0.02^c$	4.99 ± 0.01^c	$11.34{\pm}0.01^a$	65.02 ± 0.04^a	350.35
C	$11.79{\pm}0.01^a$	$0.75{\pm}0.05^b$	$7.36{\pm}0.3^b$	$16.80{\pm}0.00^c$	$6.22{\pm}0.02^b$	$57.06{\pm}0.49^b$	404.32
C^I	5.28 ± 0.01^c	$4.20{\pm}0.01^a$	$9.03{\pm}0.01^b$	5.56 ± 0.01^b	$12.06{\pm}0.01^a$	63.87 ± 0.23^a	353.76
D	$11.85{\pm}0.05^a$	$0.60{\pm}0.04^b$	$7.45{\pm}0.0^a$	$18.27{\pm}0.00^d$	$6.42{\pm}0.02^b$	$55.45{\pm}0.15^b$	411.91
D^I	4.96 ± 0.02^c	$3.85{\pm}0.01^a$	$9.48{\pm}0.01^a$	5.60 ± 0.01^a	$12.33{\pm}0.02^a$	63.89 ± 0.02^a	355.28

Values are mean ± standard deviation of triplicate analyses. Values with the same superscript in the same column are statistically not significant at ($P<0.05$).

Key: SAMPLE A: Wheat: 45%Rice: 45% Groundnut: 4%Sesame Carrot: 2% SAMPLE A^I: Malted Wheat: 45%Rice: 45% Groundnut: 4%Sesame Carrot: 2%, SAMPLE B**;** Wheat: 50%Rice: 40%Groundnut: 5%Sesame: 3%Carrot: 2%, SAMPLE B^I**;** Malted Wheat: 50%Rice: 40%Groundnut: 5%Sesame: 3%Carrot: 2%, SAMPLE C: Wheat: 60 Rice: 30%Groundnut: 5%Sesame: 4%Carrot: 1%, SAMPLE C^I: Malted Wheat: 60 Rice: 30%Groundnut: 5%Sesame: 4%Carrot: 1%, SAMPLE D: Wheat: 65%Rice: 25%Groundnut: 5% Sesame: 4% Carrot: 1%, SAMPLE D^I: Malted Wheat: 65%Rice: 25%Groundnut: 5% Sesame: 4% Carrot: 1%

Table 3 Sensory attributes of the prepared gruel

Sample	Taste	Color	Aroma	Texture	Overall Acceptability
A	7.80±1.02^{b}	7.60±096 ^{b}	7.65±1.06^{b}	7.75±1.13^{b}	8.00±0.94^{b}
A^{I}	6.5 ± 0.2^{d}	6.8 ± 0.1^{c}	6.4 ± 0.2^{d}	7.0 ± 0.3^{c}	6.6 ± 0.2^{d}
B	8.05±0.92^{b}	7.61±0.91^{b}	8.10±1.04^{ab}	7.70±1.18^{b}	7.70±1.00^{bc}
B^{I}	7.2 ± 0.1^{c}	7.0 ± 0.3^{c}	7.1 ± 0.2^{c}	7.3 ± 0.2^{c}	7.4 ± 0.1^{c}
C	7.90±0.83^{b}	7.65±1.03^{b}	7.85±1.06^{b}	7.85±1.06^{b}	7.91±1.13^{b}
C^{I}	8.5 ± 0.3^{a}	8.3 ± 0.2^{a}	8.4 ± 0.1^{a}	8.6 ± 0.2^{a}	8.7 ± 0.3^{a}
D	8.50±0.67^{a}	8.10±0.99^{a}	8.05±0.97^{ab}	7.80±1.16^{b}	8.25±0.82^{ab}
D^{I}	6.0 ± 0.2^{e}	6.2 ± 0.1^{e}	6.3 ± 0.3^{d}	6.7 ± 0.1^{d}	6.5 ± 0.2^{d}

Values are mean ± standard deviation of triplicate analyses. Values with the same superscript in the same column are statistically not significant at ($P<0.05$).

Key: SAMPLE A: Wheat: 45%Rice: 45% Groundnut: 4%Sesame Carrot: 2% SAMPLE A^{I}: Malted Wheat: 45%Rice: 45% Groundnut: 4%Sesame Carrot: 2%, SAMPLE B**;** Wheat: 50%Rice: 40%Groundnut: 5%Sesame: 3%Carrot: 2%, SAMPLE B^{I}**;** Malted Wheat: 50%Rice: 40%Groundnut: 5%Sesame: 3%Carrot: 2%, SAMPLE C: Wheat: 60 Rice: 30%Groundnut: 5%Sesame: 4%Carrot: 1%, SAMPLE C^{I}: Malted Wheat: 60 Rice: 30%Groundnut: 5%Sesame: 4%Carrot: 1%, SAMPLE D: Wheat: 65%Rice: 25%Groundnut: 5% Sesame: 4% Carrot: 1%, SAMPLE D^{I}: Malted Wheat: 65%Rice: 25%Groundnut: 5% Sesame: 4% Carrot: 1%

Conclusion

Malting significantly improved the protein, fiber, and mineral content of the gruel while reducing fat and moisture. The malted gruel variants (A^{I}–D^{I}) are more nutritionally balanced, making them suitable for complementary feeding however, sample C^{I} was rated highest in term of overall acceptability among the samples for sensory attributes.

Recommendations

Shelf stability studies of malted gruel are highly recommended and optimization of malting conditions to enhance nutrient retention.

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