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Production And Quality Evaluation of Beverage from Malted Sorghum and Selected Spices (Ginger, Clove and Turmeric)

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Abstract
The need for quality improvement of non-alcoholic beverage from sorghum through supplementation with selected spices such as ginger, clove and turmeric was studied. The beverage samples were coded as sample BV1 (100% malted sorghum), sample BV2 (95% malted sorghum + 5% ginger powder), sample BV3 (95% malted sorghum + 5% clove powder) and sample BV4 (95% malted sorghum + 5% turmeric powder). The proximate, mineral composition and physicochemical properties of the beverage samples were evaluated using standard analytical procedures. The sensory properties of the beverage samples were analyzed using 9-point hedonic scale with 9 representing like extremely and 1 representing dislike extremely. The proximate composition result of the beverage samples showed that moisture ranged from 5.42 to 6.69%, ash ranged from 3.45 – 7.08%, fibre from 0.78 to 2.21%, lipid from 0.72 to 1.81%, protein from 10.70 to 10.84% and carbohydrate from 73.73 to 76.72%. The result for the mineral composition of the beverage samples indicated that magnesium varied from 6.19 to 6.58 ppm and calcium ranged from 2.62 – 5.49 ppm. The physicochemical properties of the beverage samples revealed that total titratable acidity (TTA) ranged from 0.11 to 0.22%, bulk density from 0.62 to 0.94 g/ml, specific gravity from 1.06 to 1.62, pH from 7.00 – 7.05 and total dissolved solids (TDS) from 0.24 to 0.31 ppm. The sensory properties result of the beverage samples showed that inclusion of the selected spices (ginger, clove and turmeric powder) at 5% level had no improvement on the sensory qualities evaluated. However, beverage from 100% malted sorghum was the most acceptable of all the beverage samples in respect to sensory qualities assessed. The study therefore confirmed that inclusion of the selected spices to the malted millet showed slight improvement in nutritional quality, physico-chemical properties but reduced the sensory qualities of the beverages.

Keywords: Malted sorghum beverage, spice supplementation, physicochemical properties, proximate and mineral composition, sensory evaluation

I. INTRODUCTION

Worldwide, beverage intake has grown to be a significant aspect of human lifestyles, and it is influenced more by social than by nutritional considerations. Liquids other than water that are typically consumed to relieve thirst are referred to as beverages. Nonetheless, some are used for their stimulating properties and as a replacement to make up for nutritional deficiencies. Generally, people drink a broad variety of beverages, from exotic drinks to locally made or indigenous drinks that can be either alcoholic or non-alcoholic (Ukwo*et al.*, 2019; Ukwo and Umoh 2017).

In most communities, sorghum is a great alternative to the conventional grains that are consumed on a daily basis. With almost 75% carbohydrates, it is a great source of energy. Additionally, it is a good to outstanding source of zinc, iron, and B complex vitamins. Cereal grains have been shown to have a higher total nutritional content after being malted. Malting sorghum may enhance its nutritional value, sensory appeal, and digestibility while also having a significant impact on reducing antinutrients. People with cardiovascular problems may benefit from malting's increased total dietary fiber and decreased fat intake (Asuk*et al.*, 2020; Okpalanma, 2020).

Spices are the dried portions of certain aromatic plants which are effective as flavorants, flavor enhancers, preservatives, colorants, as well as potential therapeutic agents (Kaefer and Milner, 2008).

Ginger (*Zingiberofficinale* Rosc.) has staring potential for treating a number of ailments including degenerative disorders, digestive health, cardiovascular disorders, vomiting, diabetes mellitus, and cancer (Yerima *et al.*, 2019). Clove

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(*Eugenia cariophylata*) offers tremendous phytochemical benefits such as antioxidant, antiviral, antinociceptive as well in the treatment of dental discomfort, digestive problem, oral ulceration and so on (Thangaselvabai*et al.*, 2010; Cortés-Roja *et al.,* 2014).

Turmeric (*Curcuma longa* L.) is primarily used as a treatment for inflammatory conditions as well as being versatile as stimulant, aspirant, carminative, cordeal, emenagogue, astringent, diuretic and martirnet purposes (Jurenka, 2009). Spices including ginger, clove, and turmeric possess well documented nutritional and health benefits, suggesting that malted sorghum beverages supplemented with these spices could enhance nutritional quality and support consumer health and wellness (Yerima *et al*., 2019; Cortés-Rojas *et al*., 2014; Ikpeama*et al*., 2014); hence, the need for this study.

II. MATERIALS AND METHODS

Sorghum, ginger and cloves were procured from a local market in Offa Kwara state Nigeria.

Production of Flours

Malted sorghum flour was produced according to the method described by Adejumo *et al.* (2023). Sorghum grains were washed, soaked for 12 h, malted for 7 days, oven dried at 60 °C, milled, sieved (0.04 mm), packaged in HDPE bags, and stored at ambient temperature until use. Ginger powder was produced according to the method described by Sukajang*et al*. (2010).Ginger powder was produced by washing, peeling, slicing, oven drying at 55 °C for 24 h, grinding, and sieving to 0.35 mm particle size. Clove powder was produced according to the method described by Kumar and Tanwar (2011). Clove powder was prepared by sorting, cleaning, grinding the cloves, and storing the powder in airtight containers. Turmeric powder was produced according to Tamuno (2020)'s method. Turmeric powder was obtained by sorting, washing, peeling, thinly slicing, oven drying at 60 °C for 24 h, grinding, and storing in airtight containers.

Formulation of Beverage from Malted Sorghum, Ginger, Clove and Turmeric

Beverages were formulated from malted sorghum, ginger, clove and turmeric such that; BV1 (100% malted sorghum flour), BV2 (95% malted sorghum flour + 5% ginger powder), BV3 (95% malted sorghum flour + 5% clove powder) and BV4 (95% malted sorghum flour + 5% turmeric powder).

III. ANALYTICAL METHODS

Proximate composition (Moisture, crude protein, fat, fibre, ash) of the beverage samples were determined according to the methods described by AOAC (2019) while carbohydrate was determined by differences such that;100 - % (crude protein + total ash + crude fibre + crude fat + moisture content). Physicochemical properties of the beverage samples [total titratable acidity (TTA), pH and total sugar) were determined as described by AOAC, 2010 and Buckee and Hargitt (2013) methods. Mineral composition (magnesium and calcium) of the beverage samples was determined from dry ash samples spectrophotometrically as described by Bolarinwa *et al.* (2015) while sensory evaluation of the beverage samples was determined using 9-point hedonic scale using attributes including appearance, taste, aroma, colour and overall acceptability.All analyses were conducted in duplicate, results were expressed as mean ± standard deviation, and differences among samples were evaluated using one way ANOVA in SPSS version 20.0.

IV. RESULTS AND DISCUSSION

PROXIMATE COMPOSITION OF BEVERAGE FROM MALTED SORGHUM, GINGER, CLOVE AND TURMERIC

The result for the proximate composition of beverage samples from sorghum and selected spices (ginger, clove and turmeric powder) are presented in table 1. The moisture contents of the beverage samples differed significantly ($p < .05$) with values ranging from 5.42 to 6.69%. The highest moisture content (6.69%) was observed in sample BV3 (95% malted sorghum + 5% clove powder) while the least value for moisture (5.42%) was observed in sample BV1 (100% malted sorghum). The values reported in the current study are lower than 8.13 – 8.96% reported for moisture contents of fermented millet "Ibyer" beverage enhanced with ginger powder studied by Adakole*et al.* (2021) but lower than 74.53 – 76.77% reported for moisture contents of Millet-*Vigna-racemosa* Kunun blends researched by Bolarinwa *et al.* (2015). According to Prescott *et al.* (2002), moisture contents contribute significantly to the microbial flora of food sample. Therefore, the low moisture contents of the beverage samples will not support microbial proliferation; thus, a pointer to longer shelf life of the beverage samples.

The ash contents of the beverage samples varied significantly at 95% confidence level with values ranging between 3.45 – 7.08%. 100% malted sorghum (sample BV1) had the highest ash content

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(7.08%) while the least ash content (3.45%) was observed in sample BV4 (95% malted sorghum + 5% turmeric powder). The findings of the current study are not in tandem with 1.58 – 2.1% reported for ash contents of fresh and reconstituted *kununzakizaki* studied by Ndulaka*et al.* (2014) but slightly in line with 2.66 – 4.66% reported for ash contents of fermented millet "Ibyer" beverage enhanced with ginger powder studied by Adakole*et al.* (2021) and 0.35 – 0.42% reported for ash contents of non-alcoholic beverage from cocoyam from Adedeji and Oluwalana (2014); According to Idris (2011), ash content is generally taken to be a measure of the mineral content of the original food; therefore, 100% malted sorghum beverage (sample BV1) may contain more mineral than other beverage samples.

The fibre contents of the beverage samples ranged from 0.78 to 2.21% with sample BV1 (100% malted sorghum) having the highest fibre content (2.21%) while the least value (0.78%) was observed in beverage from 100% malted sorghum (sample BV1). No significant difference ($p > .05$) was observed between the fibre contents of sample BV2 (95% malted sorghum + 5% ginger powder) and BV3 (95% malted sorghum + 5% clove powder) respectively. The crude fibre contents of the beverage samples are lower than 5.1% reported for crude fibre contents of fresh and reconstituted *kununzaki* researched by Ndulukaet *al.* (2014), 3.56 – 5.00% reported for freshly prepared and reconstituted *kunun* sample studied by Ogbonna *et al.* (2011). The crude fibre represents the indigestible portion of a food sample that remains after acid, alkali or any chemical treatment (Okaka and Okaka, 2001).

The mean results for the lipid contents of the beverage samples ranged from 0.72 to 1.81% with sample BV4 being significantly ($p < .05$) the best in lipid content (1.81%) while the least value (0.72%) was observed in sample BV1 (100% malted sorghum). Inclusion of turmeric powder at 5% improved the lipid contents as observed in sample BV4 (95% malted sorghum + 5% turmeric powder). The result showed improvement in lipid contents of the beverage samples owing to the selected spices inclusion. The values are lower than 2.40 – 4.24% reported for fat contents of fermented millet "Ibyer" beverage enhanced with ginger powder studied by Adakole*et al.* (2021), 8.46 – 12.3% reported for fat contents of beverage from tigernut-sweet potato blend studied by Idris *et al.* (2022) and 17.3 – 18.0% reported for fat contents of *kununzaki* researched by Olufunke and Oluremi (2015). Variation in values could be attributed to variation in raw materials used in the respective studies. Low lipid contents of the beverage samples may be advantageous as they will be less susceptible to lipid oxidation which is responsible for rancidity; hence, an assurance of shelf-stability maintenance.

The protein contents of the beverage samples varied from 10.70 to 10.84% with sample BV1 (100% malted sorghum) and sample BV3 (95% malted sorghum + 5% clove powder) having the highest value for protein (10.84%) while the lowest protein content (10.70%) was observed in sample BV4 (95% malted sorghum + 5% turmeric powder). No significant difference ($p < .05$) was observed between the protein contents of the beverage samples. The findings of the current work are higher than 1.13 – 4.86% reported for crude protein contents of millet-*Vigna-racemosa*Kunun blends studied by Bolarinwa *et al.* (2015) and 1.94 – 2.3% reported for protein contents of fresh *kunun-zaki* and reconstituted *kununzaki* obtained by Ndulaka*et al.* (2014). The relatively high protein contents of the beverage samples is an indication that the beverage samples will not only quench the thirst of consumers but also contribute significantly to their protein intake.

The carbohydrate contents of the beverage samples varied significantly ($p < .05$) from 73.73 – 76.72% with BV4 (95% malted sorghum + 5% turmeric powder) having the highest carbohydrate content (76.72%) while the least value (73.73%) was observed in beverage from sample BV1 (100% malted sorghum). The findings of the current study are within the range 58.38 –78.18% for malted sorghum-soy flour blends by Bolarinwa *et al.* (2015) but higher than 47.93 –54.40% for millet and sorghum malts by Okpalanma*et al.* (2021). Variation in carbohydrate contents of the beverage samples may be attributed to differences in raw materials and amylases break down of complex carbohydrates to simpler and more absorbable sugars which are utilized by growing seedlings during the early stages of germination (Okpalanma*et al.*, 2021; Yagoub *et al.*, 2008).

MINERAL COMPOSITION OF BEVERAGE FROM MALTED SORGHUM, GINGER, CLOVE AND TURMERIC

The result for the mineral composition of beverage samples from malted sorghum and selected spices (ginger, clove and turmeric powder) are as shown in table 2. The magnesium contents of the beverage samples had no significant variation ($p > .05$) with values ranging from 6.19 to 6.58 ppm. The highest value for magnesium (6.58 ppm) was observed in sample BV1 (100% malted sorghum)

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while the lowest magnesium content (6.19 ppm) was observed in sample BV4 (95% malted sorghum + 5% turmeric powder). The findings of the current study are lower than 16.42 – 18.94 mg/100 g reported for magnesium contents of ginger spiced sweet non-alcoholic beverage studied by Ukwo and Umoh (2017) and 17.03 – 20.04 mg/100 g reported for magnesium contents of cassava non-alcoholic beverage flavoured with alligator pepper and ginger. Magnesium plays a central role in the normal regulation of blood pressure and the control of arterial resistant (Ayo and Ejiogu, 2003). The formulated beverage samples in the current study could help in the regulation of fluid balance of the body and hence influence the cardiac output

The calcium contents of the beverage samples differed significantly ($p < .05$) with values ranging from 2.62 – 5.49 ppm. Sample BB4 (95% malted sorghum + 5% turmeric powder) had the highest value (5.49 ppm) while the least value (2.62 ppm) was observed in sample BV1 (100% malted sorghum). The reports of the current study are higher than 2.31 – 3.67 ppm reported for calcium contents of Millet-*Vigna-racemosa*Kunun blends studied by Bolarinwa *et al.* (2015) but lower than the findings of Ukwo and Umoh (2017) whose study reported 20.32 – 23.20 mg/100 g for calcium contents of non-alcoholic beverage from sweet potato spiced with ginger. The presence of high amount of calcium in Millet-*Vignaracemosa*kunun blends indicates that the beverage samples will enrich both children and adults diet with calcium, which is an important element in the formation and development of strong bone and teeth.

PHYSICOCHEMICAL COMPOSITION OFBEVERAGE FROM MALTED SORGHUM, GINGER, CLOVE AND TURMERIC

The physicochemical properties result of beverage samples from malted sorghum and selected spices (ginger, clove and turmeric powder) are as depicted in table 3. The total titratable acidity (TTA) of the beverage samples ranged from 0.11 to 0.22% with sample BV1 (100% malted sorghum) having the highest total titratable acidity (0.25%) while the least value (0.11%) was observed in sample BV2 (95% malted sorghum + 5% ginger powder) and BV4 (95% malted sorghum + 5% turmeric powder) respectively. Except for sample BV1, no significant variation ($p > .05$) was observed between the total titratable acidity of the beverage samples. Reduction in total titratable acidity of the beverage samples were observed owing to the selected spices supplementation. The total titratable acidity of the beverage samples are in tandem with the standard 0.05 – 1.90% for total titratable acidity of non-alcoholic beverage (Ukwo and Umoh, 2017). Our findings are in line with 0.50 – 0.8% reported for total titratable acidity of non-alcoholic beverage from cocoyam flavoured with alligator pepper and ginger studied by Adedeji and Oluwalana (2014). Contrarily, the report of Ukwo and Omoh (2017) for total titratable acidity 0.82 – 1.42% of non-alcoholic beverage from sweet potato spiced with ginger, garlic and alligator extracts are higher than the findings of the current work.

Bulk density is a measure of heaviness of a flour sample (Oladele and Aina, 2009). The mean results for the bulk density of the beverage samples were of range 0.62 to 0.94 g/ml. Sample BV3 (95% malted sorghum + 5% clove powder) had the best bulk density (0.94 g/ml) while the least value (0.62 g/ml) was observed in beverage from 100% malted sorghum (sample A). No significant variation ($p > .05$) was observed between beverage from sample BV2 (95% malted sorghum + 5% ginger powder) and sample BV4 (95% malted sorghum + 5% turmeric powder) while other beverage samples differed significantly ($p < .05$). Bulk density has effect on the packaging and transportation of food materials and higher bulk products present better packaging properties than those with low bulk density (Oladele and Aina, 2009). The report of the current study are lower than 0.45 – 0.54 reported for bulk density of sorghum-pigeon pea flour blends researched by Adebayo-Oyetoro*et al.* 2017). According to Basman *et al.* (2003), higher bulk density is desirable for greater ease of dispersibility of flours. Also, high bulk density limits the caloric and nutrient intake per feed of a child, which can result in growth faltering (Adeoti and Osundahunsi, 2017).

The specific gravity of the beverage samples were of range 1.06 to 1.62 with sample BV1 (100% malted sorghum) significantly ($p < .05$) having the highest value for specific gravity (1.62) while the lowest specific gravity value (1.06) was observed in sample BV3 (95% malted sorghum + 5% clove powder). The result indicated that inclusion of the selected spices (ginger, clove and turmeric powder) reduced the specific gravity of their respective beverages. The values are slightly in consonance with 1.01 – 1.03 reported for specific gravity of sweet potato non-alcoholic beverage flavoured with ginger, garlic and alligator pepper extract studied by Ukwo and Umoh (2017).

The pH of the beverage samples had no significant variation ($p > .05$) with values ranging between 7.00 – 7.05. Sample BV2 (95% malted sorghum + 5% ginger powder) and sample BV4

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(95% malted sorghum + 5% turmeric powder) had higher pH (7.05) than other beverage samples. The neutral pH observed for the beverage samples is an indication of optimum condition for microbial growth and proliferation. The pH of the beverage samples are higher than 4.40 – 5.84 reported for pH of sweet potato non-alcoholic beverage flavoured with ginger, garlic and alligator pepper extract studied by Ukwo and Umoh (2017) and 2.03 – 3.61 reported for pH of fresh and reconstituted *kununzaki* studied by Ndulaka*et al.* (2014).

The total dissolved solids (TDS) of the beverage samples varied from 0.24 to 0.31 ppm. 100% malted sorghum beverage (sample A) had the highest total dissolved solid (0.31 ppm) while the least total dissolve solid (0.24 ppm) was observed in sample BV2 (95% malted sorghum + 5% ginger powder). Significant variation at $p < 0.001$ were observed between the total dissolved solids of the beverage samples. Total dissolved solid (TDS) is a measure of the combined dissolved content of all inorganic and organic substances present in liquid-based foods which could be molecular, ionized, or micro-granular suspended form (Bernard and Ayeni, 2012). According to World Health Organization (WHO) (2011), the palatability of liquid-based foods with a TDS level of less than about 600 mg/L is generally considered to be good. Therefore, the total dissolved solids of the beverage samples may be considered to be safe. TDS is most important to liquid-based foods when it concerns designated uses and has been listed by the EPA as a secondary ground water and drinking water contaminants (Akpan *et al*., 2007).

SENSORY PROPERTIES OF BEVERAGE FROM MALTED SORGHUM, GINGER, CLOVE AND TURMERIC

The results for the sensory properties of beverage samples from malted sorghum and selected spices (ginger, clove- and turmeric powder) are presented in table 4. The appearance ratings of the beverage samples varied from 6.1 to 7.8 with sample BV1 (100% malted millet) having the highest value for appearance (7.8) while the lowest rating (6.1) was observed in sample BV4 (95% malted sorghum + 5% turmeric powder). No significant difference was observed between sample BV1 and BV2 (95% malted sorghum + 5% ginger powder); while similar observation was recorded for sample BV3 and sample BV4 respectively.

The mean result for the taste ratings of the beverage samples had no significant variation ($p > .05$) with values varying from 6.2 to 7.1. Sample BV2 (95% malted sorghum + 5% ginger powder) had the best value (7.1) while sample BV4 (95% malted sorghum + 5% turmeric powder) had the lowest value for taste (6.2).

In respect to aroma attributes of the beverage samples, the values were of range 6.1 to 7.3. The highest value (7.3) was observed in sample BV1 (100% malted sorghum) while the lowest rating for aroma (6.1) was observed in sample BV4.

The colour ratings of the beverage samples ranged from 5.3 to 6.8 with 100% malted sorghum (sample A) being the most acceptable (6.8) in respect to colour while the lowest value (5.3) was observed significantly ($p < .05$) in sample BV4 (95% malted sorghum + 5% turmeric powder).

The mean result for overall acceptability of the beverage samples varied from 7.1 – 8.4. 100% malted sorghum (sample A) had the best rating for overall acceptability (6.8) while the lowest value (7.1) was observed in sample BV4 (95% malted sorghum + 5% turmeric powder). Sample BV2 (95% malted sorghum + 5% ginger powder) compared favorably with sample BV1 (100% malted millet); hence, an indication that supplementation of malted sorghum with 5% ginger powder had no significant variation ($p > .05$) from the 100% malted sorghum.

Tables 4.1: Results for the proximate composition of beverage samples

Proximate Composition (%)	BV1	BV2	BV3	BV4
Moisture	5.42 ± 0.00^{a}	5.82 ± 0.02^{b}	6.69 ± 0.05^{d}	6.39 ± 0.09^{c}
Ash	7.08 ± 0.09^{d}	6.46 ± 0.14^{c}	4.44 ± 0.16^{b}	3.45 ± 0.01^{a}
Fibre	2.21 ± 0.02^{c}	0.78 ± 0.05^{a}	0.80 ± 0.01^{a}	0.93 ± 0.05^{b}
Lipid	0.72 ± 0.14^{a}	1.09 ± 0.03^{b}	1.19 ± 0.00^{b}	1.81 ± 0.01^{c}
Protein	10.84 ± 0.01^{b}	10.73 ± 0.05^{a}	10.84 ± 0.02^{b}	10.70 ± 0.00^{a}
Carbohydrate	73.73 ± 0.17^{d}	75.12 ± 0.16^{c}	76.04 ± 0.17^{b}	76.72 ± 0.10^{a}

Values are mean ± standard deviation. Data with different superscripts are significantly different at $p < .05$.
Key:

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Sample BV1 = 100% malted sorghum
Sample BV2 = 95% malted sorghum + 5% ginger powder
Sample BV3 = 95% malted sorghum + 5% clove powder
Sample BV4 = 95% malted sorghum + 5% turmeric powder

Tables 2: Results for the mineral composition of beverage samples

Mineral Composition (ppm)	**BV1**	**BV2**	**BV3**	**BV4**
Magnesium	6.58±0.37^{a}	6.34±0.04^{a}	6.21±0.00^{a}	6.19±0.01^{a}
Calcium	2.62±0.05^{a}	3.23±0.01^{c}	3.29±0.05^{b}	5.49±3.58^{a}

Values are mean ± standard deviation. Data with different superscripts are significantly different at $p < .05$.

Key:
Sample BV1 = 100% malted sorghum
Sample BV2 = 95% malted sorghum + 5% ginger powder
Sample BV3 = 95% malted sorghum + 5% clove powder
Sample BV4 = 95% malted sorghum + 5% turmeric powder

Tables 3: Result for the physicochemical properties of beverage samples

Physicochemical properties	**BV1**	**BV2**	**BV3**	**BV4**
Total titratable acidity (%)	0.22±0.00^{b}	0.11±0.03^{a}	0.14±0.00^{a}	0.11±0.01^{a}
Bulk density (g/ml)	0.62±0.01^{a}	0.90±0.01^{b}	0.94±0.02^{c}	0.90±0.00^{b}
Specific gravity	1.62±0.03^{b}	1.11±0.02^{a}	1.06±0.02^{a}	1.11±0.01^{a}
pH	7.00±0.00^{a}	7.05±0.01^{a}	7.00±0.00^{a}	7.05±0.07^{a}
Total dissolved solid (ppm)	0.31±0.02^{b}	0.24±0.02^{a}	0.25±0.04^{ab}	0.25±0.01^{ab}

Values are mean ± standard deviation. Data with different superscripts are significantly different at $p < .05$.

Key:
Sample BV1 = 100% malted sorghum
Sample BV2 = 95% malted sorghum + 5% ginger powder
Sample BV3 = 95% malted sorghum + 5% clove powder
Sample BV4 = 95% malted sorghum + 5% turmeric powder

Tables 4: Result for the sensory properties of beverage samples

Sensory Properties	**BV1**	**BV2**	**BV3**	**BV4**
Appearance	7.8±0.77^{b}	7.1±1.13^{b}	6.3±0.70^{a}	6.1±1.13^{a}
Taste	6.9±0.83^{a}	7.1±1.67^{a}	6.5±0.64^{a}	6.2±1.08^{a}
Aroma	7.3±1.49^{b}	7.2±1.42^{b}	6.5±0.83^{ab}	6.1±0.88^{a}
Colour	6.8±1.01^{b}	6.5±1.41^{b}	6.3±0.98^{b}	5.3±0.96^{a}
Overall Acceptability	8.4±0.83^{b}	8.2±1.21^{b}	7.5±0.74^{a}	7.1±0.99^{a}

Values are mean ± standard deviation. Data with different superscripts are significantly different at $p < .05$.

Key:
Sample BV1 = 100% malted sorghum
Sample BV2 = 95% malted sorghum + 5% ginger powder
Sample BV3 = 95% malted sorghum + 5% clove powder
Sample BV4 = 95% malted sorghum + 5% turmeric powder

V. CONCLUSION

Addition of ginger, clove and turmeric powder at 5% improved the lipid but maintained their respective protein content. There were also improvements in calcium content, bulk density and specific gravity. The sensory properties of the beverage samples showed decrease in sensory qualities of the beverage samples with selected spices (ginger, clove and turmeric) addition. However, beverage from 100% malted sorghum was the most acceptable of all the beverage samples in respect to sensory qualities assessed. The study therefore infers that inclusion of the selected spices to the malted millet showed slight improvement in nutritional quality, physico-chemical properties but reduced the sensory qualities of the beverages.

DECLARATION OF CONFLICT

The authors have declared no conflict of interest

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