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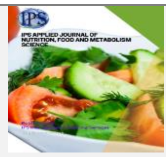

Nutrient Composition and Sensory Properties of African Yambean (*Sphenostylis stenocarpa*) and Malted Red Rice (*Oryza glabberima*) Yoghurt Analogue

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Abstract

This paper evaluated the nutrient and sensory properties of blends of African yambean (*Sphenostylis stenocarpa*) and malted red rice (*Oryza glaberrima*) yoghurt analogue. The proximate analysis of the yoghurt shows that the moisture and protein content was significantly (P<0.05) higher than the values obtained for the control. There was no significant difference (p>0.05) observed in the ash contents of both samples. The yoghurt recorded mean scores that were significantly different (P<0.05) in all tested attributes with the control. The mean scores for the sensory attributes of the AYB and malted red rice yoghurt were 8.1± 0.71, 7.9±0.4, 8.7±0.11, 7.50±0.63 and 8.08±0.69 for colour, aroma, taste, mouthfeel, sourness and overall acceptability while the control scored 9.0 in all attributes. Notwithstanding, the sensory overall acceptability of the African yambean/malted red rice yoghurt analogue was liked by the panelists. The African yambean/malted red rice yoghurt is therefore recommended for the development of a novel non-dairy probiotic yoghurt analogue.

Keywords: *Nutritional, Sensory properties, Yoghurt analogue, African yambean (AYB), Malted red rice (MRR)*

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Introduction

To live a healthy life style diet plays a major role in preventing diseases and promoting health, (Soomro *et al*., 2002). Decades of research suggests that consumption of fermented foods, especially fermented milk products is associated with improved health outcomes (Dennise and hutkins, 2020). People have noticed and become more interested in products that contain a lot of beneficial health effects. Some people are searching for alternative products that contain a similar appearance and consistency to cow milk. Therefore, plant-based milk products have become popular in recent years, such as Soya milk and almond milk (Cokro and Andrea, 2012).

Among diverse fermented milk products, yoghurt is most popular and more acceptable throughout the world (Lee and lucey,2010) because of its general positive image among consumers, as it contains health promoting ingredient (Randazzo *et al*., 2016) and is considered as a nutrient dense probiotic food with unique properties that have bioavailability of some of these nutrients and potentiality for enhancing health. Yoghurt possesses high nutritional value because of calcium, zinc and vitamin B (El-kholy *et al*., 2011) and exerts bioactive effects.

Rice (*Oryza glabberima*) is a major cereal crop consumed as a staple food by over half of the world's population. Consumption is very high in developing countries (Cokro and Romulo, 2012). The cultivation of rice ranks third in the production of agricultural commodity next to Sugarcane and maize (Rathna *et al*, 2019). Rice with a red bran layer are called red rices though the colour is confined to the bran layer, a tinge of red remains even after a high degree of milling, the colour of the bran ranges from light to dark red. The bran layer contains polyphenols and anthocyanin, and possesses antioxidant properties. The Inner portion of red and white rice is alike and white. The zinc and iron content of red rice is 2-3 times higher than that of white rice (Rood, 2000). The colourful varieties of rice are considered valuable for their health benefits (Rathna, 2019). Rice is rich in glutamic and aspartic acids but has a lower amount of lysine. The lysine content of rice protein is between 3.5 and 4.0% making it highest among cereal proteins (Rathna, 2019).

African yam bean (*Sphenostylis stenocarpa)* is an underutilized trailing legume. African yambean (AYB) is an important food substitute of cowpea in many parts of South Eastern Nigeria where it is largely grown (Ukom *et al*., 2014). African yam bean (AYB) seeds have been preferred to other legumes in the past because they are filling, though cowpea is now the preferred legume due to its availability (Nwosu, 2013).

Nutritionally, the seed is rich in protein with values ranging between 19 and 30% (Klu *et al*., 2000; Nwosu, 2013; Ndidi *et al*., 2014; Abiroye *et al*., 2015; Adeomowaye *et al*., 2015, Duodu and Apea-Bah, 2017; Anya and Ozung, 2019). The protein in AYB compares favourably with those in pigeon pea, chickpea, bambara and common bean, the bean is also rich in dietary fibre (Ndidi *et al*., 2014; Baiyeri *et al*., 2018; Anya and Ozung, 2019; Nwosu, 2013; Ndidi *et al*., 2014; Ajiobola and Olapade, 2016) and important minerals such as calcium, iron, zinc, magnesium amongst others with values higher or comparable to soy and common bean (Abioye *et al*., 2015). The levels of sodium and copper are low (Zanhi and Jideani, 2012). The essential amino acid proportion in the protein of AYB is over 32% with lysine and leucine being predominant (Duodu and Apea-Bah, 2017). The combination of a cereal and a legume helped to compliment the nutrients lacking in either of them thereby creating a synergy

This study therefore produced a non-dairy innovative rich yoghurt from African yambean and malted red rice.

Materials and Methods

African Yambean and red rice

The seeds of the African yam bean (*Sphenostylis stenocarpa Hams*), cream coloured variety (Odudu) was purchased from local retailers at Umuahia main market, Abia State, Nigeria. The red rice was sourced from Tovia Farms Ogun state.

Reagents

The reagents used were of analytical grade and were obtained from Joechem chemicals Choba Port Harcourt, Rivers State.

Microbial culture used for fermentation

The microbial culture used for fermentation was *Lactobacillus plantarum* 10CH CP 023728. De Man Ragosa Sharpe (MRS) agar and broth (oxoid) were used for isolation and enumeration of *lactobacillus plantarum*. Buffered peptone water was used as diluent for serial dilution

Malting of red rice

The red rice was malted by adoption of barley malting protocols according to Kunze (2005). Steeping of each sample was done at a temperature of 25ºC for a period of 36 h. the steep cycle involved alternating 12 h wet-steep with 45 min air-rest period. After steeping, the grains were couched (heaped) on jute bags previously sterilized with dry heat. Samples were germinated within a temperature of 30ºC, and samples were removed after the second day of germination. Kilning was performed in a hot air oven at a temperature between 70ºc for 3 h. Rice malt was continuously turned to aerate and achieve uniform controlled heat. Kilned samples were manually de-rooted by rubbing off with hand and winnowed to remove the rootlets and dust.

Production of malted red rice milk

Hundred grams (100g) of the dehulled malted red rice was dry milled in a blender. Afterwards it was sieved to obtain the powder. The powder was then mixed with water in the proportion of 1:10 w/v to form the slurry. The slurry was heated in a water bath at 100ºC for 30 min. The heated liquid was poured into sterile glass container, cooled to 25ºC and then stored at 4ºC for fermentation.

Production of African yam bean milk

The AYB seeds were sorted to remove extraneous materials. The seeds were soaked for 12 h, it was rinsed and heated for 5min at 100ºC and left to cool. The seeds were manually dehulled and blended with water in the ratio 1:8 w/v until a smooth slurry was obtained. The slurry was filtered through a double folded muslin cloth and then pasteurized at 65ºC for 30 min, it was cooled to 25ºC, bottled in a glass container and then stored in the refrigerator for further usage (Taiwo and Zulfah, 2014).

Table 1 presents the optimized ingredients ratio for AYB and MRR yoghurt analogue production. The steps for AYB and MRR production was described in Figure 1.

Table 1: Optimized ingredients ratio for AYB and MRR yoghurt analogue production

Components	AYB	MRR	XAN	INOCULUM
	0.953	0.041	0.006	8.078

Key; AYB – African yambean, **MRR** – Malted red rice**, Xan** – xanthan gum**, Inoculum –** *Lactobacillus plantarum*

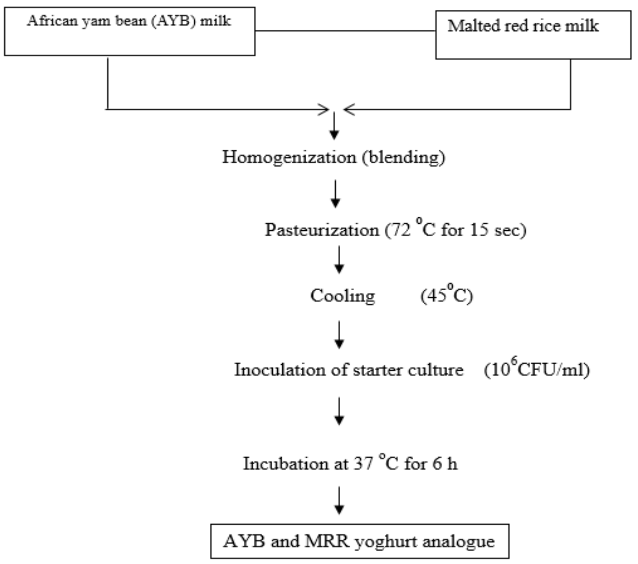

Figure 1: African Yambean (AYB) and malted red rice (MRR) yoghurt analogue.

Production of AYB / MRR yoghurt analogue

The African yam bean and malted red rice milks were mixed following the optimized runs blends, homogenized and pasteurised at 72ºC for 15sec, then cooled to 45ºC. The pasteurised mixture was inoculated with the starter culture (*Lactobacillus plantarium*) and incubated at 37ºC for 6 h. Then the AYB/MRR yoghurt analogue was packaged and stored at 4ºC for further studies.

Evaluation of proximate composition of yoghurt analogue

Protein content of the AYB and MRR yoghurt analogue

The Kjeldahl method was used for protein determination. Two millilitres of the Sample was measured into a 250 ml digestion flask. To this, 12 ml of sulphuric acid and 2 tablets of Kjeldahl catalyst was added. The content of the flask was placed on a digest furnace, set at 420ºC and digested for 1h. The digest was allowed to cool and made up to 100 ml using distilled water. Twenty ml of the digest was introduced into a 250mL Kjedahl distillation flask with 20ml of 40%. The flask was placed on the Kjedahl distillation unit and the ammonium liberated was distilled into 10 ml boric acid indicator. The distillate was titrated against 0.1 NHCl solution to a pink end-point. A blank determination was carried out and subtracted from the sample reading. The % Nitrogen and % protein was calculated as:

Crude Protein (%) = % N x 6.25

Fat content of the AYB/MRR Yoghurt analogue.

The crude fat was determined using the butt-type extraction apparatus. Two (2) ml of each fermented samples was weighed into the fat extraction flask. A glass thimble full of anhydrous - diethyl ether was added to the beaker and placed on the butt-type extraction apparatus to boil on a high temperature for approximately 4 h. The heat caused the ether to volatise and condense, extracting the ether soluble materials from the sample. The extract collected in a beaker and allowed to cool. The porous thimble removed with contents was saved for crude filter determination. Ether was distilled and collected in another container until beaker was almost dry and the remaining ether was then dried in oven.

$$\%\text{ Fat} = \frac{W_2 - W_3}{W_1} x\ 100$$

Where W_1 = weight of sample; W_3 = weight of empty extraction flask; W_2 = weight of flask + oil extract

Ash content of the AYB and malted red rice Yoghurt-like product

Five (5) ml of fermented sample was transferred into a pre-weighed porcelain crucible and weighed. The crucible was placed into muffle furnace for 3h at 600℃ to burn off all organic materials. The furnace was allowed to cool below 200℃ and maintained at this temperature for 20 min. Then the crucible was placed in a desiccator with stopper top, allowed to cool, and weighed to measure the ash content.

$$\%\text{ Ash} = \frac{W_2 - W_3}{W_1} x\ 100$$

Where W_1 = weight of sample used; W_3 = weight of empty crucible; W_2 = weight of ash + oil crucible.

Moisture content determination of the AYB and MRR Yoghurt analogue

Moisture content was determined by weighing 1 g of the sample into a clean dry porcelain evaporating dish. The sample was placed in the oven for 6 h and maintained at 105ºC. The evaporating dish was cooled in a desiccator to room temperature after which it was re-weighed. The difference in weight was calculated in percentage as the % moisture content (Osborne and Voogt, 1978; Onwuka, 2005).

$$\%\text{ Moisture content} = \frac{\text{Weight of fresh sample} - \text{Weight of dried sample}}{\text{Weight of sample used}} x100$$

Carbohydrate content determination of the AYB and MRR Yoghurt analogue

Total carbohydrate was determined by difference. It was deduced from the difference between other variable determined and 100 (Osborne and Voogt, 1978; Onwuka, 2005).

Carbohydrate (%) = 100 - (a + b + c + d)

Where, a= moisture (%), b= crude protein (%), c= ash content (%), d= ash content (%)

Sensory evaluation of the AYB and malted red rice yoghurt-like product

The degree of likeness for the probiotic yoghurt was determined using the method described by Iwe (2010). The sample was presented to a semi-trained ten-member panel who were familiar with yoghurt. The panellists were provided with 20 ml of each probiotic yoghurt sample. The samples were coded and presented to the panelists using white glass cups. Water was provided for mouth wash in between evaluations. Panelists rated the yoghurt based on the sensory attributes of colour, appearance, consistency, aroma, taste and mouthfeel using the 9-point hedonic scale. 1: dislike extremely, 2: dislike very much, 3: dislike moderately, 4: dislike slightly, 5: neither like nor dislike, 6: like slightly, 7: like moderately, 8 like very much and 9: like extremely.

Statistical Analysis

Analysis and data collection was done in triplicate. Data obtained were subjected to analysis of variance (ANOVA); means differences was evaluated using tukey's multiple comparism test with 5% confidence level. The statistical software (minitab) version 20.0 was used during the analysis.

Results

Results of the nutrient composition of the control and yoghurt samples (Table 2) showed that the percentage (%) fat of the control was significantly ($P<0.05$) higher than the % fat of the yoghurt sample while the % moisture and protein of the yoghurt sample was significantly ($P<0.05$) higher than the values obtained for the control. There was no significant difference ($P>0.05$) observed in the ash contents of both samples.

The sensory characteristics of optimised AYB/MRR yoghurt analogue with the control were presented in Table 3.

Table 2: Nutrient content of AYB/MRR yoghurt analogue

Sample	Fat	Ash	Moisture	Protein	Carbohydrate
Control	1.445 [a] ±0.01	0.5225 [a] ±0.0	88.54 [b] ±0.01	1.885 [b] ±0.01	7.6075 [a] ±0.8
Yoghurt	1.355 [b] ±0.01	0.51 [a] ±0.01	88.955 [a] ±0.07	2.14 [a] ±0.01	7.045 [b] ±0.1

Values are means of triplicate determination ± standard deviation
Means with similar superscript on the same column showed no significant difference (P>0.05)
Control- commercial yoghurt.

Table 3: Sensory characteristics of optimised AYB/MRR yoghurt analogue with the control.

Attribute	Colour	Aroma	Taste	Mouthfeel	Sourness	Overall acceptability
Sample	8.1 [a]± 0.71	7.9 [a] ± 0.4	8.7 [a] ±0.11	7.50 [a] ±0.63	8.08 [a] ±0.9	8.2 [a] ±0.9
Control	9.0 [b] ± 00	9.0 [b] ± 00	9.0 [b] ± 00	9.0 [b] ± 00	9.0± [b] 00	9.0 [b] ± 00

Values are Means of triplicate determination ± Standard Deviation (M±SD)
Means with similar superscript in the same column do not differ significantly (P>0.05)
Control- commercial yoghurt.

Discussion

Protein content of the AYB and malted red rice yoghurt analogue

The protein content of the probiotic yoghurt was 2.14. From previous reports, milk from legumes are good sources of protein which are credited with significant lowering of body cholesterol levels (Farinde *et al*., 2008; Hogervorst *et al.*, 2008). This result shows that this sample could be used to enhance the protein intake of diets (Wang *et al*., 2008).

Fat contents of the AYB and malted red rice yoghurt-like product

The fat content of the probiotic yoghurt was 1.36. This finding agreed with the report of Barber *et al.,* (2021), who observed a low fat content in soy-yoghurt hydrolysed with African bread fruit. The level of fat in this sample was less than the recommended level (10%) by the codex Alimentarius Standard for fermented milk (CODEX STAN 243-2003) (FAO and WHO, 2011). The fat in the sample is a concentrated form of energy which can protect the body, serving as insulator against temperature and environmental changes.

Ash content of the AYB and malted red rice yoghurt-like product

The ash content of the yoghurt was 0.51. The ash content of the sample was similar to the report of Barber *et al.,* (2021), Amanze and Amanze, (2011) and Makunjuola, (2012) but lower for those reported for other plant-based yoghurts (Oyeyipo *et a.,l* 2012). The ash content of a product is an indication of its mineral content Barber *et al.,* (2020).

Moisture content of the AYB and malted red rice yoghurt

The moisture content of the yoghurt was 88.96. The moisture content was comparable to the report by Baber *et al.* (2012), Ifediba and Nwafor, (2018). The result was higher than 81.32% reported by Junior *et al.,* (2012) and lower than 91.63 for soy yoghurt (Amanze and Amanze, (2011). The high moisture content could affect the stability and safety of the products with respect to microbial growth and proliferation, hence, the product require cold storage for shelf-life extension.

Sensory characteristics of the AYB and malted red rice yoghurt analogue

The result of the sensory evaluation of the panellists is presented in table 2. In this study the probiotic yoghurt recorded mean scores that were significantly different (P<0.05) in all tested attributes with the control. The mean scores of the AYB and malted red rice yoghurt were 8.1, 7.9, 8.7, 7.50 and 8.08 for colour, aroma, taste, mouthfeel, sourness and overall acceptability. While the control was 9.0 in all attributes. Notwithstanding, the sensory overall acceptability of the probiotic AYB and malted red rice was liked by the panelists.

Conclusion

This study has shown that Yoghurt produced from fermentation of African Yambean and Malted red rice using *Lactobacillus plantarum* strain were safe with high nutritive values and low antinutrient values.

Competing interests

The authors report no conflicts of interest.

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