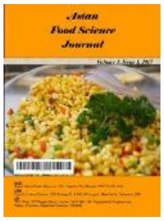

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Nutritional Compositions and Sensory Properties of Composite Flour from FARO 44 Rice (*Oryza sativa*)-TMS 8082 Cassava (*Manihot esculenta*) and Its Paste

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Authors' contributions

This work was carried out in collaboration between all authors. Author GIO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors COMO and MOI managed the analyses of the study. Author COMO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to investigate the nutritional properties of unsoaked and soaked FARO 44 flour with their blends with cassava flour and the sensory evaluation of their thick paste. FAR0 44 and cassava flour were blended in the ratio of 75:25 (Unsoaked Rice and Cassava) sample, 50:50 (Unsoaked Rice and Cassava) sample, 25:75 (Unsoaked Rice and Cassava) sample, 75:25 (Soaked rice and Cassava) sample, 50:50 (Soaked rice and Cassava) sample, 25:75 (Soaked rice and Cassava) sample, 100% (cassava) sample 100% (Unsoaked Rice) sample 100% (Soaked rice) sample. The proximate analysis and mineral composition of the flour blends were conducted. Proximate composition data indicated an increased level of protein, fat, ash, crude fibre and carbohydrate (2.47-16.73%, 1.11-1.78%, 4.13-8.27%, 0.44-5.27% and 58.72-73.35%) respectively. The unsoaked and soaked rice flours and their blends where their ratios were high had higher protein content. There was a significant different (P<0.05) in the mineral content of the composites

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samples. Data of these study shows that the rice and cassava samples had good mineral content and the raw and soaked rice did not significantly affect the mineral content of the samples. The result indicates that vitamins A and C were significantly different (P<0.05) in the samples except for samples 100 UR and 100 SR where vitamin A was not detected. The thick paste prepared for the sensory evaluation shows that samples with 100 SR, 75 SR 25 C, 50 SR 50 C were most accepted in appearance than the other sample as compared favourably with sample 100 C. The results also show that the under-utilized cereal crop like FARO 44 rice flour and their composites with cassava are nutritionally adequate for consumption for adult and children, as well as the production of baby foods and the lot.

Keywords: FARO 44 rice; cassava; nutritional; sensory; composite flour; dough.

1. INTRODUCTION

The major public health problem in many developing countries in the world such as Nigeria is protein malnutrition and has led to different forms of malnutrition in both children and adults [1]. Rice (*Oryza Sativa*) is a staple food for over 3 billion people, consisting over half of the world's population. It is one of the most important cereal for human consumption [2,3]. In Nigeria, Abakaliki and Ikwo in Ebonyi State, Adani, Ugboka and Uduma in Enugu State and Omor in Anambra State are rice producing areas in the South-Eastern part of Nigeria [4]. In recent years, Africa Rice Center (WARDA) has introduced several rice varieties, together with efficient natural resource/crop management and pest and disease management technologies to rice farmers in Nigeria and other West and Central African countries. Typical examples are the high yielding rice varieties: FARO 44 (SIPI), FARO 51 (CISADANE), FARO 52 (WITA 4) etc. FARO 44 is an improved rice variety produced by The Federal Agricultural Research Oryza. Unlike traditional varieties that are typically more than 1 meter tall, have a long growth and maturation period (five to six months) and low yield (1.5-2.0 tonnes per hectar), the improved varieties are shorter (less than 50 centimetres), responsive to high doses of fertilizer, have a high yield (3.5-5 tonnes per hectar), short duration crops that may provide three harvests per year and also have high resistance to drought [5]. Local rice comprises all locally produced in Nigeria. This kind of rice retains a lot of their naturalness because they have not gone through chemical processes. They are said to be more nutritious when compared to the imported rice this is because of its natural state. Despite the local rice high nutritional content, they are still underutilized and no company utilized them as its raw materials [6]. Consumers demand the fine varieties is high, however, what is not clear is that the premium price consumers pay is based on the physical or chemical qualities [7]. Our improved local rice which has been perceived to be more nutritious and has good health benefits than the foreign rice is still poorly utilized due to its poor processing methods and its quality. Also, rice has been limited to only one pattern of usage, i.e. boiled. Therefore a work to explore the use of rice for other product is most welcome. Rice also suffers from another factor which is that it is not a raw material for any industry. The breweries drive sorghum, textiles drive cotton, and the pharmaceuticals drive cassava. Cassava (*Manihot esculenta* Crantz) is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world. Cassava is a major staple crop in Nigeria, cassava and its product are found in the daily meals of Nigerians [8]. Incorporating cereal flours in cassava meals could also be important sources of plant protein in the diet of people in tropical developing countries where animal protein is unavailable to the majority of the population [9]. This study aimed at producing composite rice – cassava flour blends to produce a paste, this is to improve the utilisation of rice and serves as product development. It will also investigate the nutritional and sensory properties of the different composite rice – cassava flours.

2. MATERIALS AND METHODS

2.1 Sample Collection

The raw materials for this study are FARO 44 (Mars) and cassava TMS 8082 (*Manihot esculenta*). The FARO 44 (Mars) was purchased from Abakaliki market while the cassava TMS 8082 (*Manihot esculenta*) was obtained from National Root Crops Research Institute, Umudike in Abia state, Nigeria.

2.2 Processing of Rice Flour

FARO 44 (Mars) rice was processed into two samples – the soaked and unsoaked samples.

The FARO 44 (Mars) was cleaned, sorted and divided into 2 portions. The first portion was soaked in water for 12h at 25ºC and then washed and dried in an oven for 12h at 60°C and cooled. After cooling, it was milled in an attrition mill, sieved with 2.0 mm mesh screen to obtain the rice flour and then packaged in a plastic container. The other part of FARO 44 (unsoaked) was milled in an attrition mill and sieved with 2.0 mm mesh screen and then packaged in an airtight plastic container.

2.3 Processing of Cassava Flour

Freshly harvested cassava roots of TMS 8082 (*Manihot esculenta* Crantz) was processed into the flour using a modified method as described by Osungbaro et al. [10]. The cassava roots were washed, peeled, and re-washed with clean potable water. They were steeped in water in plastic containers for 72 h. At the end of the steeping period the fermented samples were rewashed with fresh water and grated into pulp using a 3.5 Hp, petrol engine powered grater. The fermented, soft pulp was dispersed in water and sieved with a test sieve with an aperture of 2.0 mm. The recovered sediment was packed in sacks and dewatered using a hydraulic press for 2 days. The resulting cake was pulverized by hand, spread in trays, then in an oven at a temperature of 60°C for 15 min. The dried fermented cassava flour was milled into flour using a disc attrition mill, sieved through 2.0 mm mesh screen, then packaged in an airtight plastic container.

2.4 Composite Flour

The composite flours were obtained by blending unsoaked FARO 44 rice flour with cassava flour and soaked FARO 44 rice flour with cassava flour. The flours were mixed at the ratios of 75%, 50% and 25% of the unsoaked FARO 44 rice (R) to 25%, 50% and 75% of cassava flour (C) respectively, with 75%, 50% and 25% of the soaked FARO 44 rice (SR) to 25%, 50% and 75% of cassava flour. There was 100% (R), 100% (SR) flour and 100% (C) (the control).

2.5 Chemical Analysis

The proximate composition of the samples was determined using AOAC [11]. The samples were analyzed for moisture content, ash, crude protein, lipids and crude fibre. Carbohydrates content was determined by differences. The mineral (sodium, calcium, magnesium and phosphorus) contents were determined using the standard method according to AOAC [12]. The vitamins compositions of the samples were determined using Barakat titration method for Ascorbic acid and vitamin A according to AOAC [11].

2.6 Sensory Evaluation

A 50 g of flour samples was stirred in 175 ml boiling water to make a smooth thick paste which was allowed to cook for 20 min, with constant stirring to achieve a constant consistency and each sample was packaged in a polyehthene film for sensory evaluation [13]. Five variables were used for this study to test for acceptability of the paste. The variables are appearance, texture, odour, mouldability, and general acceptability. The panel was comprised of a 20 - man semi-trained panelist to test the parameters for the paste. The panelists were provided with water to rinse their mouths before and after tasting each sample. A 9 point hedonic scale was used where 1 represents dislike extremely and 9 like extremely [14].

2.7 Statistical Analysis

All data obtained from the nutritional composition of the flour samples and sensory properties of the paste were recorded in triplicate and subjected to One-way analysis of variance (ANOVA) which was used to analyze the significant difference ($P<0.05$) of the mean of the samples using Statistical Program for Social Science (SPSS) version 21.0 (IBM SPSS inc., Chicago, [15].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Samples

Table 1 shows the results of the proximate composition of the nine different flour samples. In term of the moisture content, there was no significant difference observed between samples 50 R 50 C and 75 SR 25 C but there was a significant difference between them and the rest of the samples. The moisture content ranged from 8.55-17.23%. Samples 100 C, 100 R, 100 SR, 75 R 25 C, 50 R C 50, 25 R 75 C had values ranged from 8.55 – 13.53%, these values were within the 15% acceptable value for long time storage of grains and acceptable limit of dry product [16]. Gerona [17] and Sajise and Hag [18] found that food samples dried to 11 – 14% moisture stored for up to 4 months without deterioration. This was also pointed out by Fish and Trim [19] that dried samples are stable. Samples 75 SR 25 C, 50 SR 50 C and 25 SR 75 C had higher moisture contents than the other samples, and this may be attributed to the fact that their rice was soaked in water before processing [3].

The ash content values ranged from 4.13 – 8.27%. The ash content of a food sample gives an idea of the mineral elements present in the food. Samples with high percentages of ash content are expected to have high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development [20]. Sample 100 C had the highest ash value of 8.27% and the rest of the samples had a reasonable amount of ash ranging from 4.13 – 6.53%.

The protein contents for the nine different samples ranged from 2.47 – 16.73%. Sample 100 C had the least value of 2.47%, this is expected because cassava is known to be low in protein. The two FARO 44 rice samples 100 R (15.77%) and 100 SR (15.63%) had high protein values. This result obtained from these samples of rice flour composites were similar to the results obtained by Adebayo-Oyetoro et al. [21] on ofada rice and bambara groundnut flour of 17.6% and Falola et al. [1] on ofada rice and soybean flour of 15.6%.The FARO 44 rice samples had high protein both in raw and soaked state and this could be attributed to planting, processing, storage and transportation method employed during and after harvesting [3]. Its blends with cassava also had high protein values ranging from 14.47 to 16.73%. There was a slight reduction in the protein level of the samples with rice flour soaked in water and this could be because of solubility of some protein [3]. Dipti et al. [22] reported that the standard value for rice is 7 % and values less than 6% are regarded as low and may not meet the nutritional needs of children. The protein content of all the samples except for samples 100 C was above the standard value of 7% and may definitely contribute to the nutritional needs of children and adults. The higher protein values FARO 44 rice flour and its blends with cassava will be nutritional importance in most developing countries like Nigeria where as many people can hardly afford high proteinous foods because of their cost [1].

Crude fibre is the residue which remains after the material has been treated under standardized conditions. It consists largely of cellulose together with a little lignin. It doesn't represent a measure of a specific group of substances [23]. Certain physiological responses have been associated with the dietary fibre, such as an increase in faecal bulk, lowering of plasma cholesterol, and lowering of nutrient bioavailability [24].

The crude fibre content of the different samples had values ranging from 0.44 - 5.27%. There was no significant different (P>0.05) between samples 50SR 50C and 25SR 75C but there was significantly different between them and the rest of the samples. Sample 100 C had the highest

Table 1. Proximate composition of FARO 44 (Mars) rice –cassava (TMS 8082) composite flour at different proportions

Samples	Moisture%	Ash%	Protein%	Crude fibre%	Fat %	Carbohydrate%
100 C	9.53^g	8.27^a	2.47^d	5.27^a	1.11^h	73.35^a
100 R	8.55^h	4.13^e	15.77^b	0.56^f	1.61^c	69.37^b
100 SR	10.43^f	4.50^{de}	15.63^b	0.44^g	1.27^g	67.72^c
75 R 25 C	12.43^e	4.67^d	15.47^b	0.75^e	1.38^e	64.97^d
50 R 50 C	13.53^d	5.60^c	16.73^a	1.35^b	1.78^a	60.86^g
25 R 75 C	13.40^d	6.53^b	14.47^c	1.05^d	1.43^d	63.13^e
75 SR 25 C	15.57^c	4.77^d	15.47^b	0.65^{ef}	1.44^d	62.11^f
50 SR 50 C	16.30^b	5.53^c	16.47^a	1.27^{bc}	1.71^b	58.72^i
25 SR 75 C	17.23^c	5.77^c	14.73^c	1.23^c	1.34^f	59.70^h
LSD	0.37	0.22	1.87	0.70	0.02	0.46

Values are means of data of triplicate determinations values in the same column having the same superscript are not significant different (P>0.05).C-Cassava, R- Rice, SR- Soaked rice fibre content values (5.27%). The high amount of fibre in cassava follows the fact that cassava contains a high amount of dietary fibre, which can help prevent constipation. The blends with cassava flour were seen to have higher crude fibre values than the two rice samples. The range obtained in this study was similar to the range of 1.93 - 4.39% reported by Edeogu et al. [25] for staple food crops. Milling of rice generally decreases the fibre content of rice as reported by Sotelo et al. [26] who analyzed the chemical compositions of different fractions of 12 Mexican varieties of rice obtained during milling. Samples 75 SR 25 C, 50 SR 50 C and 25 SR 75 C had higher fibre value than the other samples blended with rice that wasn't soaked in water. Dietary fibre helps in the reduction of bowl disorders and fights constipation [3].

The fat content of the flour samples ranged from 1.11 to 1.78% and were observed to vary significantly (P<0.05) except for samples 25 R 75 C and 75 SR 25 C where there was no significant difference. Sample 50 R 50 C had the highest fat content values (1.78%), followed by sample 50 SR 50 C. Sample 100C had the least value (1.11%). The result did not differ much from the values reported by Alaka and Okaka [7] physical and proximate composition of some indigenous rice varieties in south Eastern Nigeria with values ranging from 1.11 to 1.87%. The fat values of the samples were low and not affected by the soaking in water of rice. This observation was also reported by Ebuehi and Oyewole [3] on the effect of cooking and soaking of indigenous and foreign rice varieties in Nigeria. Fat is located in various part of each grain, therefore, method and level of milling could affect lipid content drastically [27]. The samples with the unsoaked rice that samples 100 R, sample 50 R 50 C and 25R 75C had higher fat values. The fat contents obtained in this study is lower than the recommended 10% [28] this implies that the storage life of the mix may increase due to its low fat content, resulting in low susceptibility to oxidative rancidity [29].

The samples contained carbohydrate ranging from 58.72 – 73.35%. Sample 100 C had the highest carbohydrate value (73.35%) while sample 50SR 50C had the least value of (58.72%) followed by sample 25 SR 75 C with the value of 59.70%. Samples 75 SR 25 C, 50 SR 50 C and 25 SR 75 C had lower values for the rest of the samples; this could be attributed to the fact that these samples had higher moisture content. The percentage of carbohydrate contents of these samples showed that these blends are good source of energy [20]. Carbohydrates also contribute to the bulk of the energy of the mix, which makes them ideal for growth.

3.2 Mineral and Vitamins Compositions of Samples

The results of the mineral (calcium, magnesium, sodium and phosphorus) and specific vitamins (vitamins A and C) analysis of the formulated samples are shown in Table 2.

Mineral analysis in Table 2 showed that there was significantly different (P<0.05) in the calcium content of the samples. Sample 100 SR had the highest value of calcium 5.25 mg/100 g while sample 100 C had the least value of 2.26 mg/100 g. The samples that had high ratio of cassava were also observed to have good calcium values. Calcium is by far the most important mineral that the body requires and its deficiency is more prevalent than many other minerals, it helps in the formation of strong bone and teeth [30].

In terms of Magnesium, there was a significant difference (P<0.05) between the samples except for samples 75 SR 25 C and 25 SR 75 C. The magnesium contents of the formulated samples range from 17.43 to 48.13 mg/100 g, where sample 75 SR 25 C had the highest value while sample 100 SR had the least value. Magnesium has a vital role in varying range of biochemical and physiological processes. It is also important for nerve and heat function as well as insulin release from the pancreas and ultimate insulin action on cells [31].

In terms of Sodium, there was significantly different (P<0.05) existing between the samples. Sample 100 SR had the highest sodium value of 2.57 mg/100 g, followed by sample 100 R with value of 2.43 mg/100 g while sample 100 C had the least value of 0.28 mg/100 g. Sodium is the major positive ion (cation) in extracellular fluid and a key factor in retaining body fluids. It also helps regulate the fluid balance of the body both within and outside the cells [31].

In terms of potassium, there was a significant difference (P<0.05) between the samples. The potassium value ranges from 117.24 to 433.29 mg/100 g. Sample 100 C had the highest value 433.29 mg/100 g while sample 100 R had the

Table 2. Mineral and vitamins compositions of FARO 44 (Mars) rice – cassava (TMS 8082) composite flour at different proportions

Samples	Calcium (mg/100 g)	Magnesium (mg/100 g)	Sodium (mg/100 g)	Potassium (mg/100 g)	Phosphorus (mg/100 g)	Vitamin A (mg)	Vitamin C (mg)
100 C	2.26^{i}	20.10^{f}	0.28^{i}	433.29^{a}	24.03^{h}	25.27^{a}	1.85^{a}
100 R	4.56^{b}	17.80^{g}	2.43^{b}	117.24^{i}	65.10^{d}	ND	0.22^{f}
100 SR	5.25^{a}	17.43^{h}	2.59^{a}	125.26^{h}	63.57^{e}	ND	0.26^{e}
75 R 25 C	3.26^{e}	36.30^{e}	0.36^{h}	258.56^{e}	67.23^{c}	10.20^{d}	0.34^{d}
50 R 50 C	3.12^{f}	45.67^{d}	0.45^{g}	345.48^{c}	72.17^{a}	10.37^{d}	0.37^{c}
25 R 75 C	2.54^{h}	48.13^{b}	0.54^{f}	318.46^{d}	62.13^{g}	14.07^{b}	0.42^{b}
75 SR 25 C	3.66^{c}	48.63^{a}	1.21^{c}	234.44^{f}	63.53^{e}	8.50^{e}	0.24^{g}
50 SR 50 C	3.36^{d}	46.13^{c}	1.16^{d}	352.13^{b}	71.67^{b}	11.07^{c}	0.25^{ef}
25 SR 75 C	2.78^{g}	48.40^{ab}	0.97^{e}	214.44^{g}	62.50^{f}	10.10^{d}	0.10^{h}
LSD	0.03	0.20	0.01	0.04	0.17	0.19	0.01

Values are means of data of triplicate determinations values in the same column having the same superscript are not significantly different ($p>0.05$). ND- Not detected. C- Cassava, R- Rice, SR- Soaked rice least value 117.24 mg/100g followed by sample 100 SR with a value of 125.26 mg/100 g. The two 100% rice samples were seen to have low potassium value. Sample 75 R 25 C and sample 75 SR 25 C which had a high ratio of rice were also seen to have low potassium value. Potassium balance fluid in the body and helps in nerve impulse transmission. It also influences the contractility of smooth, skeletal and cardiac muscle [31]. Potassium found in abundance in the samples has shown to be an important mineral in the control of hypertension and in the reduction of risk of stroke [32].

In the phosphorus content, there was no significant difference (P>0.05) between samples100 SR and 75SR 25C but there was a significant difference (P<0.05) between them and the rest of the formulated samples. The phosphorus value of the samples ranges from 24.03 to 72.17 mg/100 g. Sample 50 R 50 C had highest value 72.17 mg/100 g followed by sample 50 SR 50 C with a value of 71.67 mg/100 g while sample 100 C had the least value 24.03 mg/100 g. It was noticed that the two samples that had the highest value of phosphorus had equal ratio of rice and cassava. Phosphorus is essential for the production of energy in the body [30]. Phosphorus also helps in bone and teeth in the form of calcium phosphate and also participates in the acid-base balance in the body [31].

Data of the present study shows that raw and soaking in water of rice do not significantly affect the mineral content of the rice samples and their composite flours. This observation was similar to the ones made by Ebuehi and Oyewole, [3] on the evaluation of indigenous rice. These samples contain useful quantities of calcium, magnesium, sodium, phosphorus and potassium. These observations support previous reports [3]. These samples are good sources of minerals which could contribute to the recommended dietary allowance [33].

Minerals are constituents of bones, teeth, soft tissues, muscle, blood and nerve cells. They are vital for overall mental and physical well being. Minerals act as co-factors for many biological reactions within the body including muscle contraction, neuro-transmission, and production of hormones, digestion and utilization of nutrients [3].

In term of vitamin A content, there was a significant difference (P<0.05) between the formulated samples except for samples 75R 25C and 50 R 50 C which showed no significant difference (P>0.05). Sample 100 C had the highest value of vitamin A with 25.27 mg while in samples 100 R and 100 SR, vitamin A was not detected. The samples that had high ratio of rice both for the (soaked and unsoaked rice) was samples 75 R 25 C and 75 SR 25 C had the least values of 10.10 mg and 8.50 mg respectively. Vitamin A is very essential for growth, reproduction good vision, healthy skin, hair, nails and to balance energy level in the human body. The deficiency of vitamin A in the body causes keratomalciaia (night blindness) [34].

There was no significant difference (P>0.05) between samples C (Soaked rice 100%), B (Rice 100%) and 50 SR 50 C in term of vitamin C. There was a significant difference (P<0.05) between them and the rest of the samples. The value of vitamin C ranged from 0.10 to 1.85 mg. Sample 100 C had the highest value 1.85 mg and sample 25 SR 75 C had the least value 0.10 mg. The other samples were also low in vitamin C.

Badamossi et al. [35] reported that the local formulation would have to be further fortified with micronutrients to meet the needs of humans adequately. Since these food samples will be eaten with vegetables which contain high mineral and vitamins, they may be able to complement the quantity present in the samples.

3.3 Sensory Evaluation of Thick Paste

The results of the sensory evaluation of the formulated samples formed into thick paste are presented in Table 3. In terms of appearance, there was no significant different (P>0.05) between the samples except for samples 100 SR, 75 SR 25 C, 50 SR 50 C and samples 50 R 50 C, 25R 75C. Samples 75 SR 25 C and 50 SR 50C had the highest values of 8.3 and closely followed by sample 100 SR with value of 8.25. The good appearance of samples 100 SR, 75 SR 25 C, and 50 SR 50 C may be attributed to the fact that the rice was soaked in water which gave it a bright appearance.

In the case of odour and texture, there was no significant different (P>0.05) between the thick paste formed from the other samples and the control. The reason could be due to the fact that the cassava was deodorized during processing and when blended with rice masked the odour.

Table 3. Sensory evaluations of thick paste food prepared from FARO 44 (Mars) rice –cassava (TMS 8082) composite flour

Samples	Appearance	Texture	Odour	Mouldability	Acceptability
100 C	7.55^{ab}	7.80^{a}	7.70^{a}	7.90^{ab}	7.95^{a}
100 R	7.50^{ab}	7.40^{a}	7.80^{a}	7.90^{ab}	7.80^{a}
100 SR	8.25^{a}	7.95^{a}	7.90^{a}	8.25^{ab}	8.25^{a}
75 R 25 C	7.35^{ab}	7.45^{a}	7.70^{a}	7.45^{ab}	7.65^{a}
50 R 50 C	6.80^{b}	7.30^{a}	7.45^{a}	7.50^{ab}	7.40^{a}
25 R 75 C	6.50^{b}	7.45^{a}	7.35^{a}	7.55^{ab}	7.40^{a}
75 SR 25 C	8.30^{a}	7.95^{a}	7.85^{a}	8.40^{a}	8.20^{a}
50 SR 50 C	8.30^{a}	8.05^{a}	7.60^{a}	8.10^{ab}	8.20^{a}
25 SR 75 C	7.35^{ab}	7.25^{a}	7.50^{a}	7.40^{b}	7.95^{a}
LSD	0.77	0.75	0.72	0.61	0.60

Values are means of data of triplicate determinations values in the same column having the same superscript are not significantly different (p>0.05). C-Cassava, R- Rice, SR- Soaked rice

Texture of staple food 'tuwo' is an important quality attribute that usually influences consumers acceptability of product [36]. Hardacre and Clark [37] observed that a food staple (e.g. fufu, 'tuwo') usually exhibits variation in the rheological characteristics as a result of different degrees of interactions of flour components (that is, protein, fat, fibre and non-starch polysaccharides) with solubilized amylose and amylopectin components of the starch granules during heating. The hardness/softness index of the staple can be used to stimulate the force required to compress the food product between the tongue and palate which is normally a preliminary action usually carried out in the mouth during consumption and can lead to whether the food product will eventually be chewed or swallowed. Fufu-like staple, like many other traditional staple foods, is consumed by swallowing rather than being masticated or chewed and it is the prevailing textural characteristics of the product, at the point of consumption, that usually determines whether such food is swallowable or chewable [38]. Therefore, high hardness index can predispose the food product towards being masticated or chewed while relative high value encourages swallowability.

In term of mouldability, there was no significant difference (P>0.05) between the samples except for samples 75 SR 25 C and 25 SR 75 C. The samples with soaked rice i.e samples 100 SR, 75 SR 25 C, and 50 SR 50 C had higher scores of 8.25, 8.40, and 8.10 respectively, they were most preferred in the case of mouldability and compared favourably with 100 C. All the other samples compared favourably with 100 C.

In term of acceptability, there was no significant difference (P>0.05) between the samples. All the samples compared favorably with sample 100 C which has already gained popularity. This shows that all the flour samples could be used for dough making and other baked products.

4. CONCLUSION

The study showed that the composite flours from FARO 44 rice and cassava (TMS 8082) are nutritionally adequate and showed good sensory acceptability when it was prepared into paste. The composite flours showed a considerable improvement in the protein content of the flour blended with rice flour. The high protein obtained in this study will also help reduce the incidence of protein energy malnutrition (PEM) thereby making rice (FARO 44) and its blends ideal substitution for cassava, wheat and foreign rice. The flour samples also showed high fibre. The flour samples showed a considerable improvement in the mineral elements present. The paste products from the flour and composite flour samples were well accepted compared with the control 100C, the product will also be cheap and readily available. FARO 44 rice (mars) - cassava flour can be used as a substitute for cassava flour, thus enhancing its economic importance and reducing dependence on cassava for the production of paste.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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