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Evaluation of the Functional and Pasting Properties of Composite FARO 44 rice- Cassava (TMS 8082) Flour Meals

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Abstract:
This study was carried out to evaluate the functional, pasting and chemical properties of unsoaked and soaked FARO 44 (Mars) rice flour and its composites with cassava flour. Different flour of FAR0 44 rice and cassava flour were blended in the ratio of 100% (Cassava) sample (control), 100% (Unsoaked Rice) sample, 100% (Soaked Rice) sample, 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. The highest starch yield of 74.49% was obtained by sample 100 Rice flour. The amylose content of the samples ranges from 23.26 to 26.36%. The sugar content of the samples also ranges from 5.25 to 6.96%. The result of the functional properties of the flour blends shows that, the bulk density ranged from 0.87- 2.88%, water absorption capacity 2.47 - 3.93%, oil absorption capacity 2.03 - 3.83%, pH 3.90 - 5.20, swelling index 1.06 -1.29cm^3, and solubility 76.07 - 84.91%. In pasting properties, peak viscosity ranged between 128.50 - 243.00RVU, trough, breakdown, final and setback viscosity varied from 87.42 - 162.42 RVU, 41.08 - 99.17 RVU, 160.58 - 280.58 RVU and 59.50 - 118.17 RVU respectively. The good pasting behaviour and functional properties of the samples make FARO 44 rice flour with cassava flour blend, could be used in the production of stiff dough products and other baked products with good palatability and water binding capacities leading to their utilization in food product development.

Keyword: *FARO 44 rice, cassava, functional, chemical, pasting, properties*

1. Introduction

Cereal grains such as rice or roots like cassava are made into flour by grinding them into powder (Eke-Ejiofor and Owuno, 2012). In Nigeria, rice is grown in all the ecological and dietary zones, with each ecology having different varieties of processing adaptation traits (Sanni *et al*., 2005; Ebuehi and Oyewole, 2007).

Rice is a tropical and economic crop, which has shown its importance in household food security, ceremonies, income generation and employment. It is mostly being utilized at household level where it is consumed as boiled, fried or ground rice with soup and stew (Ebuehi and Oyewole, 2007).

Cassava (*Manihot esculenta Crantz*) is a tropical and subtropical root crop which is grown in the world (Burrel, 2003). In the tropics, it serves as the third most important food source after cereal crops such as rice, maize etc. (Osungbara *et al*., 2010). Drawback of cassava includes its low protein content, low energy density and the potential toxicity from the presence of the cyanogenic glucosides, linamarin and lotaustralin (Dunstan *et al*., 1996; Osungbara *et al*., 2010).

Incorporating cereal flours in cassava meals could also be important sources of plant protein in the diet of people in developing countries where animal protein is not readily available or costly (Aminigo and Akingbala, 2004). The use of composite flour in the production of starchy meals or products most times alters their compositions and therefore leading to a change in their functional and pasting characteristics of the final product (Adetuyi *et al*., 2009).

The amount of amylose content, protein and fat content and the processing techniques applied determine the physical characteristics of the final food product (Onitilo *et al*., 2004; Osungbaro, 1990).

This study was aimed at producing composite rice (FARO 44) – cassava (TMS 8082) flour blends, this is to improve the utilization of rice and its application in new product development. Also, investigating the functional, pasting and chemical properties of different flour composite blends would identify the suitability of the blends for incorporation in to different product formulation.

2. Materials and Methods

2.1. Raw Material

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

2.2. Processing of Rice

FARO 44 (Mars) rice was processed into two samples – the soaked and unsoaked. FARO 44 (Mars) was cleaned, sorted and divided into 2 portions. The first portions were soaked in water for 12 h at 25^{o}C and then washed and dried in an oven for 12 h at 60^{0}C and cooled. After cooling, it was milled in an attrition mill, sieved through 2.0 mm mesh screen to obtain rice flour and then packaged in a plastic container. The other part of FARO 44 (unsoaked) was milled in an attrition mill and sieved through 2.0 mm mesh screen and then packaged in an airtight plastic container.

2.3. Processing of Cassava Flour

Freshly harvested cassava roots TMS 8082 (*Manihot esculenta Crantz*) was processed into flour using a modified method as described by Osungbaru *et al*. (2010). The cassava roots were washed, peeled, and re-washed with clean portable water. Washed roots were steeped in water in a plastic container for 72 h. At the end of the steeping period, the fermented roots 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 aperture of 2.0 mm. The recovered sediment was packed in sacks and dewatered using a hydraulic press for 2days. The resulting cake was pulverized by hand, spread in trays and dried in the sun, then in an oven at a temperature of 60^{o}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 air tight plastic container.

2.4. Composite Flour Formulation

The composite flours were obtained by blending FARO 44 rice with cassava flour and soaked FARO 44 rice flour with cassava flour. The blending of mixing was 75%, 50% and 25% of the FARO 44 rice to 25%, 50% and 75% of cassava flour respectively, with 75%, 50% and 25% of the soaked FARO 44 rice to 25%, 50% and 75% of cassava flour. There were 100% FARO 44 rice flour, 100% soaked FARO 44 rice flour and 100% cassava flour (as the control).

2.5. Chemical Analysis

Starch content was determined by method described by Pearson (1976). The Amylose content using Rapid calorimetric method was used as described by Alexander and Griffith (1993). Amylopectin content was determined by the difference between starch content and amylose content. Sugar determination was by acid hydrolysis method described by Radley (1976).

2.6. Functional Properties

The methods described by Onwuka (2005) were used to determine the bulk density, gelation capacity, gelation temperature, wettability, water absorption capacity (WAC), oil absorption capacity (OAC), pH measurement and solubility in water; while swelling index was determined as describe by Ukpabi and Ndimele (1990).

2.7. Pasting Properties Determination

The pasting properties of the samples were evaluated by using a Rapid Visco Analyzer (Newport Scientific, RVA Super 3, Switzerland). The following parameters were obtained from the pasting profile: peak viscosity, pasting temperature, setback viscosity, breakdown viscosity, final viscosity and time to reach the peak viscosity.

2.8. Statistical Analysis

Data obtained from nutritional and sensory evaluation of the paste were recorded in triplicates and subjected to One-way analysis of variance (ANOVA) using Statistical Program for Social Science (SPSS) version 21.0 (IBM SPSS inc., Chicago, IL). Where difference existed, LSD was used to separate means and accepted at 5% significance level (Adeboye *et al.,* 2015).

3. Result and Discussion

3.1. Chemical Properties of the Flour Samples

The result of the chemical properties of the composite flour samples is shown in Table 1.

There was significant difference ($P<0.05$) in the starch content of the formulated samples. The starch content of the formulated samples ranged from 68.36 to 74.49%. Sample 100 R had the highest value of 74.49% followed by 100 SR with value of 73.87%

while sample 25SR 75C had the least value of 68.36%. The values obtained were slightly higher than values obtained for wheat/three leavened yam composites which ranges from 52.72 to 68.85 reported by Eke-Ejiofor and Owuno (2012). Samples 75SR 25C, 50SR 50C and 25SR75C had lower starch contents and this may be attributed to the rice being soaked in water leading to lost in some of the starch via leaching.

The sugar content of these formulated samples ranged from 5.25 to 6.96%. There was no significant difference (P>0.05) between samples 75R 25C and 50SR 50C but there was significant difference (P<0.05) between them and the rest of the samples. Sample 100 R had the highest value of 6.96% and sample 50SR 50C had the least value of 5.52%. The values obtained from this study were within the range of values obtained from the sugar content of wheat/three leaved yam composite which ranged from 3.17 to 8.38% as reported by Eke-Ejiofor and Owuno (2012). The amount of sugar in diet should not be more than 10% of the daily total energy intake (Khazar *et al.*, 2004). The amount of sugar in the formulated samples could be said to be at a safe level.

Physicochemical and metabolic properties of rice are influenced by numerous factors. One of these factors is amylose content, which is often used to predict starch digestion rate, blood glucose and insulin responses to rice. Starchy foods that are rich in amylose content are associated with lower blood glucose levels and slower emptying of human gastrointestinal tract compared to those with low levels of amylose (Mir *et al.,* 2013).

The amylose content is simply the linear molecular structure of starch. It has a strong bond and therefore takes a lot of energy to breakdown during digestion due to its tightly packed structure. It was reported to be an effective probiotic. Amylose content of the formulated samples ranges from 23.26 to 26.36% with sample 100 R recording the highest value 26.36% and sample 100 C having the least value 23.26%. There was significant difference (P<0.05) that existed between the samples. The amylose content of raw materials is an important factor with regards to the end use properties of various products such as noodles and dough (Sievert and Lausanne, 1993).

Samples	Starch %	Sugar %	Amylose %	Amylopectin %
100 C	73.63^{c}	6.36^{c}	23.26^{i}	50.38^{a}
100 R	74.49^{a}	6.96^{a}	26.36^{a}	48.12^{d}
100 SR	73.87^{b}	6.59^{b}	25.53^{b}	48.34^{c}
75 R 25 C	72.46^{d}	5.57^{d}	24.47^{f}	47.98^{e}
50 R 50 C	72.17^{e}	5.35^{f}	23.36^{h}	48.81^{b}
25 R 75 C	69.88^{f}	5.25^{h}	24.47^{e}	45.41^{f}
75 SR 25 C	69.54^{g}	5.45^{e}	25.16^{c}	44.39^{h}
50 SR 50 C	68.85^{h}	5.59^{d}	24.78^{d}	44.07^{i}
25 SR 75 C	68.36^{i}	5.28^{g}	23.67^{g}	44.70^{g}
LSD	0.02	0.02	0.01	0.02

Table 1: Chemical compositions of the FARO 44 (Mars) rice –cassava (TMS 8082) composite flour at different proportions
Values are means of data of triplicate determinations. Values in the same column having the same superscript are not significant difference (P>0.05). C-Cassava, R- Rice, SR- Soaked rice

The amylose contents reported in this study are within the range 27.6 to 38.2% and 23.21 to 33.74% for *Dioscorea alata* flour and wheat/three leaven yam composite respectively (Hoover, 2001; Eke-Ejiofor and Owuno, 2012). Amylose positively influences the functioning of the digestive tract microbial flora, the blood cholesterol level and the glycemic index and assists in the control of diabetes (Fuentes-Zaragoza *et al*., 2010). Rice is generally known to have a relatively high glycemic index compared to other starchy foods. There is an inverse relationship between glycemic index and amylose content hence the lower the amylose content, the higher the glycemic index scale and vice versa (Hu *et al*., 2004). This is an indication that the high amylose values of the samples seen in this study the lower the glycemic index, this attributed would be good for diabetic patient to consume.

Structural property of starch is determined by the level of amylose and amylopectin of the starch. Slaughter *et al*. (2000), in a study with wheat starch gels observed that the rate of starch hydrolysis decreases markedly when amylose leaches out of the granule. Studies with high-amylose maize starch gels at different starch concentrations and pure amylose and amylopectin gels showed that the higher the amylose content, the higher the gel rigidity and the lower the hydrolysis rate in vitro and in vivo (Autio *et al*., 2002). This implies that the higher the amylose content the slower the hydrolysis /digestion of starch and thus, the slower its glycemic response will be and subsequently, the lower the glycemic index.

Low amylose content has been linked to high swelling power due to low reinforcement of internal work by amylose molecules (Hoover, 2001). It has been well known that rice with high amylose content provides dry and fluffy textures while low amylose rice gives moist, chewy and clingy textures after cooking. The proportion of amylose and amylopectin affected the hardness of rice starch gel (Hibi, 1998). Generally, high-amylose rice varieties give high hardness, high tensile strength, and high consistency (Lu *et al*., 2009). The high amylose content reported in this study may be due to the fact that blends are still in their raw form, as further processing may reduce amylose content. In agreement with the above statement, Raja and Ramakrishma (1990) reported that heat treatment caused a reduction in amylose content of starch based product. Since this formulated samples will still pass through heat before consumption it is so likely that the amylose content will be further reduced.

Amylopectin of the formulated samples ranged from 44.07 to 58.36%. There was significant difference (P<0.05) between the nine formulated samples. Sample 100 C had the highest value of 58.36% and sample 50SR 50C had the least value of 44.07%. Amylose decreased with an increase in amylopectin meaning that one is a function to the other and both properties are important in food preparation and development.

3.2. Functional Properties of Flour Samples

The result of the functional properties of the formulated flour samples is presented in Table 2.

Functional properties are the properties, which define the consumers' requirement. They determine the application and use of food material for various food products. They are the characteristics which determine the suitability of the food stuff for a given purpose. Bulk density is a measure of heaviness of a flour sample. It is the ratio of mass per unit volume of a substance. It is an indication of porosity of a product which influences the package design. It also relates to mouth feel and flavour. An increase in bulk density of flour enhances fat absorption. The high volume per gram of flour material is important in relation to its packaging (Okezie and Bello, 1988).

In terms of bulk density there was significant difference (P<0.05) between samples 100 R and 100 SR while, there was no significant difference (P>0.05) between the rest of the samples. The bulk density was higher in sample 100 SR with value of 2.88g/ml followed by sample 100 R with value of 2.29g/ml. Sample 25SR 75C had the least bulk density value of 0.87g/ml. The bulk density content of the samples ranged from 0.87 – 2.88 g/ml. Bulk density also indicates the volume of the packaging material required. Samples 25SR75C and 100 C had lower bulk density values of 0.87g/ml and 0.97g/ml respectively; this could indicate that cassava flour is a little denser than rice flour. This may be attributed to the particle size of cassava flour granules, a bed of fine particles will compact with loading as the packing order of the particles is distributed (Babajide and Olowe, 2013). It was observed that the samples with higher cassava flour ratio samples 25R 75C and 25SR 75C were seen to have lower bulk density than the rest of the samples. The low bulk density values of all the samples indicate that packaging will be easier.

The water absorption capacity of food material is an index of the maximum amount of water that it can take up and retain; hence determine the energy and nutrient dense of a food. Imbibition of water is an important property of all flours used in food preparations. Water absorption capacity is the ability of flour to absorb water and swell for improves yield and consistency in food (Osunahunsi *et al*., 2003).

In terms of water absorption capacity (WAC), the values obtained for the samples ranged from 2.47 to 3.93 g/ml. Sample 100 R had the highest WAC value of 3.93g/ml while sample 50R 50C had the least WAC value of 2.47g/ml. The increase in the WAC suggests possible increase in the level of incorporation into dough formulation as well as improvement in handling characteristics. Water binding capacity is a useful indication of whether flour can be incorporated into aqueous food formulations especially those involving dough handling (Giami, 1993).

Samples	Bulk density (g/ml)	Water absorption capacity (g/ml)	Oil absorption capacity (g/ml)	Ph	Swelling index (cm^3)	Gelation temperature (^oC)	Least gelation capacity (w/v)	Solubility (%)
100 C	0.97^c	2.83^{de}	3.83^a	3.90^i	1.27^b	60.67^d	6.00^a	76.07^e
100 R	2.29^b	3.93^a	2.03^e	5.20^a	1.25^c	65.00^c	2.00^c	82.97^{ab}
100 SR	2.88^a	3.70^a	2.51^c	5.10^b	1.28^b	71.33^b	2.00^c	83.38^a
75 R 25 C	1.25^c	2.97^{cd}	2.08^{de}	4.73^c	1.08^g	76.33^a	4.00^b	79.10^{cd}
50 R 50 C	1.27^c	2.47^f	2.29^{cde}	4.70^{de}	1.21^f	63.33^{cd}	4.00^b	78.97^d
25 R 75 C	1.15^c	3.40^b	2.42^{cd}	4.20^g	1.06^h	60.67^d	6.00^a	81.18^{bc}
75 SR 25 C	1.30^c	3.15^{bc}	2.95^b	4.63^e	1.29^a	70.67^b	4.00^b	84.12^a
50 SR 50 C	1.04^c	2.90^{cd}	3.08^b	4.50^f	1.25^c	62.67^{cd}	6.00^a	84.21^a
25 SR 75 C	0.87^c	2.60^{ef}	2.99^b	4.00^h	1.23^d	60.67^d	6.00^a	84.91^a
LSD	0.28	0.16	0.23	0.47	0.01	2.11	0.01	1.27

Table 2: Functional properties of FARO 44 (Mars) rice –cassava (TMS 8082) composite flour at different proportions
Values are means of data of triplicate determinations values in the same column having the same superscript are not significant difference (p>0.05). C-Cassava, R- Rice, SR- Soaked rice

High water absorption capacity may imbibe a disproportionate amount of water and would dehydrate other components. Interaction of protein with water is important to gelation, solubility, swelling and hydration. Water absorption capacity depends on ionic-strength, pH, temperature, size and shape of protein molecules (Onimawo and Akubor, 2005). Water absorption capacity is important in the development of ready to eat food cereal grains, since a high-water absorption capacity may assure product cohesiveness (Bhattacharya and Brakask, 1994).

The result of the pH shows that there was no significant difference (P>0.05) between samples 50R 50C and 75SR 25C, but there was significant difference between them and the rest of the samples. The pH value ranges from 3.90 – 5.20. The pH of the nine different samples was within acidic medium. Low pH in flours helps to improve the shelf life during storage (Onwueme, 1987). As the percentage of cassava flour in rice flour was increased, the pH reduced gradually probably because the pH of cassava was the lowest (3.90). This could be attributed to the production of cassava which involved in 3-days steeping period (Oyewole and Afolami 2001).

There was significant difference (P<0.05) among the samples for swelling index except samples 100R and 25R 75C. The swelling index values ranged from 1.06 – 1.29 cm^3. Sample 75SR 25C had the highest value 1.29cm^3while sample 25R 75C had the least value

1.06cm^3. Samples 75SR 25C, 50SR 50C and 25SR 75C were shown to have higher swelling index than the rest of the samples with rice that wasn't soaked in water. Safo-Kantanka and Acquistucci. (1996) stated that the swelling power of a starch based food is an indication of the strength of the hydrogen bonding between granules. Richard *et al*. (1991) further described swelling power as a factor of the amylose to amylopectin, the characteristics of each fraction in terms of molecular weight/ distribution, degreed/length of branding and conformation. The ratio of swelling power to water absorption capacity is an indication of the reconstitution ability. Eke-Ejiofor and Owuno (2012) stated that the swelling power of a starch based food is an indication of the strength of the hydrogen bonding between the granules. Sanni *et al*. (2005) reported that the swelling index of granules reflects the extent of associative forces within the granules, therefore the higher the swelling index the lower the associative force. This indicates that the samples could have high associative forces within the granules because of the low swelling index value.

Swelling index is the volume of expansion of molecules in response to water uptake which possesses until a colloidal suspension is achieved or until further expansion and uptake is prevented by intermolecular forces in swelled particles (Adetuyi *et al*., 2009). The extent of swelling in the presence of water depends on the temperature, availability of water, species of starch, extent of starch damage due to thermal and mechanical processes and other carbohydrates and protein such as pectin, hemicellulose and cellulose etc (Ezeama, 1989).

Oil absorption capacity is due to binding of fat by non-polar side chains of proteins. These are of practical importance in food formulation. Oil absorption capacity is important since oil acts as flavour retainer and increase mouth feel of foods. It has also been reported that the variations in the presence of non-polar side chains of oil among flours, explain differences in the oil binding (Adebowale and Lawal, 2004). Oil absorption capacity is attributed to the protein content of the food (Richest *et al*., 1974). It also been reported that protein binds more water (Pamashree *et al*., 1987).

From Table 2, the oil absorption capacity (OAC) result showed that sample 100 C had the highest value of 3.83 g/ml while sample 100 SR had the least value of 2.03 g/ml. The samples were seen to have high oil absorption. Since oil acts to retain flavour and increase the mouth feel of foods, oil absorption is an important property in such food formulations (Bhattacharya and Brakask, 1994). Moreover, OAC is useful in structure, interaction in food especially in flavour retention improvement of palatability and extension of shelf life particularly in baking (Adebowale and Lawal, 2004). It was also noticed that the samples with rice that was soaked in water and the samples that had higher cassava ratio had higher oil absorption capacity than the rest of the samples.

The gelation temperature ranged from 60.67^{o}C to 76.33^{o}C for the formulated samples. There was significant difference ($P<0.05$) that existed among samples C (Soaked rice 100%), and 75R 25C but there was no significant difference ($P<0.05$) among them rest of the samples. Gelation temperatures obtained in this study suggests that, flour blends can be incorporated into foods that do not have high gelation temperature requirement. The relative ratio of the components i.e. carbohydrates, lipids and proteins that make up cereals and interaction between these compounds have a significant role in their functional properties (Sathe *et al*., 1982). This gelling property makes them suitable to be incorporated in foods like dough and sauce which require thickening and gelling.

3.3. Pasting Properties of Flour Samples

The pasting properties of the formulated flour samples are presented in Table 3. When heat is applied to starch based foods in the presence of water, a series of changes occur, these changes are known as gelatinization and pasting. They influence the quality and aesthetic considerations in food industry such as the texture, digestibility and starchy nature (Babajide and Olowe, 2013).

The Peak Viscosity (PV), which is the maximum viscosity developed during or soon after the heating portion of the samples ranged from 128.50 to 243.08 RVU. Sample 100 C had the highest value of 243.08 RVU at a temperature of 75.55^{o}C in 5.85 min and sample 25SR 75C had the lowest value of 128.50 RVU at a temperature of 80.66^{o}C in 5.46min. The PV of the other samples was also high in relative to sample 100 C. The PV indicates the water binding capacity of the starch or mixture in a product correlates with final product quality and provides an indication of the viscous load likely to be encountered by a mixing cooker (Ingbian and Adegoke, 2007). It is also an indication of the ability of the products to swell freely before their physical breakdown. The increase in PV of the flour samples may be attributed to the processing method of long drying time of sample under low temperature which allows for more starch degradation or debranching to simpler unit which is an indication of starch structural damage (Tunde-Akintunde and Akintunde, 2011). The high PV value noted in this study could be of processing advantage. This high Peak Viscosity indicates that the rice and cassava flour samples can be used for product requiring high gel strength and elasticity (Olanipekun *et al*., 2009). High peak viscosity has been reported to be significant in the preparation of stiff dough products like 'tuwo shinkafa', a stiff dough product made from cereal flour and eaten with stew and vegetable (Danbaba *et al*., 2012).

The Trough Viscosity (TV) for the rice and cassava flour samples ranged from 87.42 to 162.42 RVU. The values obtained from the various flour samples were significantly different at $P<0.05$. The values obtained in this study are similar to the range of 80.3 to 117.2 for Ofada rice as reported by Danbaba *et al.* (2012). Trough Viscosity is the point at which the viscosity reaches its minimum during either the heating or cooling process. Peak viscosity is usually followed by a breakdown to minimum (trough viscosity) as a result of starch granules rupture and leaching during exposure to high temperature and shear (Normita and Cruz, 2002). The significantly ($P\leq0.05$) high trough viscosity observed in all the samples in this study indicates the tendency of the rice and cassava samples to breakdown during cooking. For rice, a higher breakdown is considered to be an indicator of better palatability. In a study comparing the physiochemical of rice cultivar showed that the one with the highest breakdown value rated the most palatable (Tran *et al*., 2001).

Samples	Peak viscosity(PV) (RVU)	Trough viscosity(TV) (RVU)	Breakdown viscosity(BV) (RVU)	Final viscosity(FV) (RVU)	Setback viscosity(SV) (RVU)	Pasting time (Min)	Pasting temp ^{o}C
100 C	243.08[a]	143.92[e]	99.17[a]	260.75[b]	116.83[b]	5.85[b]	75.55[i]
100 R	234.92[b]	155.00[c]	79.92[c]	256.17[c]	101.17[c]	5.46[d]	79.86[h]
100 SR	217.58[e]	162.42[a]	55.17[h]	280.58[a]	118.17[a]	5.22[f]	83.25[a]
75 R 25 C	210.67[f]	144.33[d]	66.33[f]	231.42[f]	87.08[f]	5.09[g]	81.45[e]
50 R 50 C	208.67[g]	140.75[f]	67.92[e]	226.08[g]	85.34[g]	5.75[c]	82.63[b]
25 R 75 C	222.08[c]	140.42[g]	81.67[b]	233.00[e]	92.58[e]	5.95[a]	81.47[d]
75 SR 25 C	221.42[d]	157.00[b]	64.42[g]	237.08[d]	80.08[h]	5.22[f]	82.36[c]
50 SR 50 C	175.67[h]	101.08[h]	74.58[d]	160.58[i]	59.50[i]	5.35[e]	80.25[g]
25 SR 75 C	128.50[i]	87.42[i]	41.08[i]	186.42[h]	99.00[d]	5.46[d]	80.66[f]
LSD	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 3: Pasting properties of FARO 44 (Mars) rice –cassava (TMS 8082) composite flour at different proportions
Values are means of data of triplicate determinations values in the same column having the same superscript are not significant difference (p>0.05). C-Cassava, R- Rice, SR- Soaked rice

The breakdown viscosity (BV) of the samples ranges from 41.08 to 99.17 RVU. The highest value 99.17 RVU was obtained by sample 100 C while sample 25SR 75C had the least value 41.08 RVU. There was significant difference (P<0.05) between the samples. The values obtained in this study were above the range of 4.2 to 44 RVU for Ofada rice reported by Danbaba *et al.* (2012). The values obtained were within the range of 41.06 to 221.78 RVU for quality of tapioca reported by Tunde-Akintunde and Akintunde. (2011). Adebowale *et al*. (2005) reported the higher the breakdown in viscosity, the lower the ability of the sample to withstand heating and shear stress during cooking. Cohesiveness of paste is attributed to the extent of breakdown of starch molecules during heating and stirring. The low breakdown viscosity of the samples indicates its cohesiveness and subsequently higher paste stability.
The result also revealed that samples 100 SR and 100 C recorded the highest setback viscosity value of 118.17 and 116.83 RVU while sample 50SR 50C recorded the least value of 59.50 RVU. This result is an indication that samples 100 SR and 75R 25C posses the highest ability to remain undisrupted when subjected to a long period of constant high temperature and able to withstand breakdown during cooking (Osungbaro *et al.,* 2010). There was significant difference (P<0.05) between the samples. The values obtained from this study were lower than the value recorded for Ofada rice varieties ranging from 104.3 to 143.5 RVU (Danbaba *et al*., 2011) but they were similar to range of 50.6 to 85.05 RVU reported by Tunde-Akintude and Akintude. (2012). Setback viscosity has been correlated with the texture of various end products. High setback viscosity is also an indication of the amount of swelling power of the rice samples and is usually related to the amylose content of the sample (Jennifer and Les, 2004). Setback viscosity indicates the tendency of starch to retrograde on cooling.
The final viscosity (FV) varied between 160.58 to 280 RVU with sample 100 SR having the highest value of 280.58 RVU followed by sample 100 C with value of 260.75 RVU and sample 50SR 50C had the least value of 160.58 RVU. There was significant difference (P<0.05) observed among the samples. The values obtained in this study are similar to the range of 190.3 to 261 RVU reported for Ofada rice varieties (Danbaba *et al*., 2012). The final viscosity is the most commonly used parameter to determine a particular starch based sample quality. It gives an idea of the ability of starch to gel after cooking.
The pasting time of the samples varied from 5.09 to 5.95 min with sample 75R 25C having the least value and sample 25R 75C having the highest value. There was no significant difference (P>0.05) between samples 100 R and 25SR 75C but there was significant difference (P<0.05) between them and the rest of the samples. Pasting time provides an indication of the minimum temperature required to cook flour. Pasting time values reported in this study are similar to the pasting time of 5.13 to 5.80 min and 5.01 to 6.3 min for instant yam-bread fruit composite flour and germinated tigernut flour respectively (Adebowale *et al*., 2008; Chinma *et al*., 2009).
The pasting temperature (PT) of the different rice and cassava flour samples ranged from 75.55 to 83.25^{o}C, the highest value was recorded in sample 100 SR and the lowest range was in sample 100 C.
The values of the PT obtained from this study were higher than 49.30 to 49.70^{o}C reported by Eke-Ejiofor and Owuno (2012) for wheat/three leaved yam composite. This could be because of the high moisture content of the samples. The pasting temperature indicates the range of temperature where at least 90% of starch granules swell irreversibly in hot water with loss of crystallinity and birefringence (Cruz and Khush, 2000). The values obtained in this study were higher than 64.1 to 64.7^{o}C; 73.1 to 75.2^{o}C; 63.85 to 64.47^{o}C reported for Ofada rice varieties, different pea cultivars and tigernut respectively (Kaur *et al*., 2007; Chinma *et al*., 2009 and Danbaba *et al*., 2012).

4. Conclusion

The results obtained in the study have shown that the chemical, functional and pasting properties were influenced by blending ratios and different processing methods. The chemical characteristics of the flour samples revealed that they have high amylose content which indicates that it will form paste and gel and will be good for making dough, noodles and other baking products. The flour samples showed good pasting and functional properties especially for water absorption capacity (WAC) which indicates the extent to which water can be added during dough formation using the different flour samples. The study showed that the flour samples will be good for paste and dough formation. These will bring about better opportunities for improved industrial uses of the blends and FARO 44 rice and the manufacture of starchy meal.

5. References

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