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Effect of Maturity and Drying Methods on Rheological and Physico-Chemical Properties of Reconstituted Breadfruit (Artocarpus altilis) Flour.

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Abstract: - Breadfruit (*Artocarpus altilis*) is a traditional staple crop grown for its starchy fruit throughout Oceania. This study therefore investigated the effect of maturity and different drying methods on some rheological and physicochemical properties of reconstituted breadfruit flour (*Artocarpus altilis) (amala).* Freshly harvested breadfruits (mature and immature) were washed in clean water to remove adhering latex and dirt, peeled, rewashed, drained and sliced. The sliced fruits were divided into three portions, each portion was dried in oven, sun, biomass fuelled dryer at 60 ºC for some hours respectively until constant weights were observed. All the samples were milled with attrition mill, sieved with 0.35 mm aperture and each packaged in a 0.5mm thick plastic container, each sample was reconstituted, and the following analyses were carried out on the reconstituted breadfruit flour: proximate, compression, softness index, antinutritional, colour and sensory evaluation using standard methods. The result of proximate analysis showed (17.77, 14.50 and 13.82), (68.08, 75.45 and 78.03%) and (0.71, 0.45 and 0.46%) for protein, carbohydrate and crude fibre for matured sun, biomass fuelled and oven dried samples respectively and, (16.44, 12.38 and 7.54), (77.95, 78.26 and 84.30), (0.28, 0.50 and 0.47) for protein, carbohydrate and crude fibre for immatured sun, biomass fuelled and oven dried samples respectively. The Sun dried sample showed the highest protein content for both matured and immatured samples. Generally, it was observed that drying and reconstitution reduced the antinutritional content of breadfruit flour, while maturity and drying methods have little effect on the softness Index of the reconstituted breadfruit flour. The overall acceptability for sun and oven dried samples are the most acceptable. For production of high quality breadfruit flour, biomass drying of matured fruits is recommended because of its high protein content and low antinutritional factors though sun dried sample has higher protein content but past research works showed that sun drying method is susceptible to high microbial load. *

Keywords: - *Breadfruit, Drying, Rheological, Physico-chemical, Reconstitution, Antinutritional Softness index.*

I. INTRODUCTION

Breadfruit (*Artocarpus altilis*) is a traditional staple crop grown for its starchy fruit throughout Oceania (Ragone, 1997). Breadfruit trees grow well on hillsides, protecting watersheds, providing erosion control, and windbreaks. The canopy provides beneficial shade for plants and people and the large leaves create mulch. It is used as a trellis tree for yam. The fruit is an important food source for flying foxes, native doves, and other birds in the Pacific islands. Breadfruit is well adapted to the wet tropics, doing best at temperatures ranging from 21-32 °C with an annual rainfall of 1525-2540mm and adequate drainage (Ragone, 1997, 2006a). Cooler temperatures often result in low yields and increased plant mortality (Lebegin *et al*., 2007). Breadfruit yields of 6 t/ha (edible dry weight) have been reported (Sauerborn, 2002). This is an impressive yield compared to the current predominant staple crops, with average yields of 4.11 t/ha for rice. The tree has a great productive ability with an average sized tree producing 400 to 600 fruits per year (NTBG, 2009). It has been reported that breadfruit yields in terms of food are superior to other starchy staples such as cassava and yam (Singh, 2009). When fully ripe, the fruit is soft; the interior is creamy coloured and pasty, also sweetly fragrant. The mature fruit is a good source of carbohydrate (84%) with starch constituting more than 60% of the total carbohydrate (Oladunjoye *et al.*, 2010). Breadfruit has been processed into many forms for utilization. After peeling, the fruits are boiled, pounded and eaten with soups just like pounded yam. Processing of breadfruit into starches (Loos *et al*., 1991) and flour (Olatunji and Akerele, 1998) has also been reported. Although, breadfruit is nutritious, cheap and available in high abundance during its season, it has found limited applications in the food industries (Omobuwajo, 2003). In Nigeria, it is predominantly found in some parts of the country which include Ibadan, Ogbomosho, Akure, and Ikire.

One major factor limiting its availability is its poor storability, as the fruits undergo rapid physiological deterioration after harvesting. In many food-deficit countries, the need to fully utilize all existing foodstuffs with a view to alleviating poverty and hunger is now receiving considerable attention. One way to minimize post-harvest losses and increase the utilization of breadfruit is through processing into flour, which is a more stable intermediate product (Ragone and Cavaletto, 2006). The flour can then be the starting material for processing through reconstitution with hot water to form a paste (Amala). 'Amala' is a common food item in Nigeria and some other West African countries. It is made from processed roots and tuber crops like, yams, cassava and these may be fortified with other food items like soya, plantain and wheat just to mention a few. (Abulude and Ojediran, 2006). It can be eaten anytime of the day with stew, vegetables and other types of soup.

Drying methods and the physicochemical changes that occur in tissues during drying affect the quality of the dehydrated products. More specifically, the method used for drying affects properties such as colour, texture, density, porosity and sorption characteristics of materials (Krokida *et al.,* 1998). High quality, convenient products are obtained efficiently at a fast rate and at competitive costs by several methods of drying. Traditionally, breadfruit slices are mainly dried in the open, under the sun. Sun-drying represents a low cost processing method of preserving agricultural produce in the tropics. Open sun drying, however, has some limitations. These include the inability to control the drying process and parameters, weather uncertainties, high labour costs, the requirement of a large drying area, insect infestation, and contamination with dust and other undesirable materials (Sankat and Mujaffar, 2004). The drying of wet materials induces a number of physico-chemical changes in the product, often reflected by colour. By choosing suitable drying methods and the appropriate conditions, the final product quality can be controlled. Biomass fuelled dryer are also drying methods, the main advantage is that their temperature can be controlled during drying compared with sun drying.

This study is geared towards utilization of breadfruit for amala rather than cooking, the main aim of this study therefore was to evaluate the effect of drying methods and level of maturity on rheological, physicochemical properties and consumer acceptability of reconstituted breadfruit flour (amala).

II. MATERIALS AND METHODS

Sample Preparation

Breadfruits flour samples were prepared following the method of Olaoye et al 2006. Fresh breadfruits (mature and immature) gotten from a local village in Osun State was washed in clean water to remove adhering latex and dirt and was peeled, washed again, drained, sliced to 3 mm thick using FUTA slicer. This was divided into three portions. a portion was oven dried at 60 ºC Another portion was dried with biomass fuelled cabinet dryer at the same temperature while the third portion was dried in the Sun. Weights of each sample was monitored during drying until constant weight was achieved. Each sample was milled with attrition milling machine sieved with 2.0 micrometer sieve and was packaged in a different container (See Plates 1 -5). The flours were reconstituted to amala.

Plate 1: Whole breadfruit

Plate 2: Peeled breadfruit

Plate 3: Sliced breadfruits

Plate 4: Biomass fuelled dried breadfruit.

Plate 5: Sun dried breadfruit

The Analyses Carried Out include:

Proximate Composition

The methods described by AOAC, (2005) were used to determine protein, moisture, crude fibre, ash content and the carbohydrate content was determined by difference on the breadfruit flour.

Determination of Anti nutrients

Tannin determination

The tannin content of the reconstituted breadfruit flour (breadfruit amala) was determined by Van – Burden and Robinson (1981) reported by Onimawo and Egbekun, (1998).

Phytic acid determination

Method of Young and Greaves (1940) reported by Onimawo and Egbekun (1998) was used.

Determination of oxalate

The oxalate content of the reconstituted breadfruit flours were determined by Day and Underwood (1986), reported by Onimawo and Egbekun (1998).

Colour determination

This was determined using colour meter (Color Tec PCMTM Color Tec associates, Inc., 28 Center STREET, Clinton, NJ 08809). The colorimeter operates on the CIE (Commission International de l'Eclairage) L^*, a^*, b^* colour scheme. Multiple measurements of several points on samples were made. The instrument was first standardized (L=93.24, a=00.96, b=-02.75) with a Business Xerox 80g/m^2 white paper with 136 CIE whiteness D65. About 3g of starch were put in a clean paper and the colour meter was placed on the sample by allowing the sensor to touch the sample. The reading was taken directly for L^*.The instrument display three-dimensional colour difference in uniform colour space (Lab) co-ordinates. Uniform colour space defines three directions, a Light to Dark direction, called L*, a Red to Green direction called a*, and a blue to yellow direction called b* (Yeh. *et al.,* 2002). The results from three replicates per sample were averaged. The colour purity, expressed as chroma was calculated from $(a^2+b^2)^{1/2}$ while one of the following equations was used to calculate the hue angle: if a>0 and b>o, then $h^o = [\tan^{-1}(b/a)]$.

III. RHEOLOGICAL PROPERTIES DETERMINATION

Softness index determination

The softness index of amala prepared from breadfruit flour obtained through each production method was determined using Precision Cone Penetrometer (Bench top model, Pioden Controls Ltd., UK). Freshly prepared hot reconstituted breadfruit flour was scooped inside a clean cylindrical tin container having only one end opened and a dimension of 6 cm (diameter) by 6 cm (height). After filling, the opened end was covered with an aluminium foil to prevent scale formation of the amala and the container was thereafter allowed to cool under ambient condition (30 ± 2°C). After cooling, amala inside the container was subjected to penetrometer evaluation by positioning its centre perpendicularly to the falling probe of the penetrometer. The probe was finally released to fall freely from a standard distance to penetrate into the product in the cylindrical tin container. The total depth of penetration of the probe was then read on the penetrometer scale and the reading, expressed in millimetre (mm), was taken as an index of the product softness.

Evaluation of the Compression Test on Reconstituted Breadfruit Flour (Amala)

The compression test on reconstituted breadfruit flour was done by the method of Testometric (2007) with Universal Testing Machine (Model M500 – 50KN, Testometric England). The cylindrical amala mould was placed between two parallel flat stainless steel circular plates each having a diameter of 130mm. the machine was set at a speed of 50mm/min and allowed to compress the cylindrical amala mould until the product began to rupture.

Force – deformation curves were recorded on a chart while other parameters such as compressive load at break (N), compressive strain at break(mm/mm), energy at break(J), load at break(mm), extension at break(mm) and modulus(Mpa) were generated.

Sensory Evaluation

The reconstituted breadfruit flour (breadfruit amala) from both matured and immature breadfruits, and different drying methods (oven drying, biomass fuelled drying and sun drying) samples were organoleptically evaluated by nine (9) semi trained panel of judges accessing the colour, texture, aroma, taste and overall acceptability. These scores were subjected to analysis of variance (ANOVA) and the treatment means separated using Duncan's Multiple Range Test.

Statistical Analysis

All determinations were made in triplicate and the results obtained from the various analysis were subjected to analysis of variance (ANOVA) using the statistical package for social sciences (SPSS) version 18.0. Means were separated using the Duncan multiple range test (DMRT) at 95% confidence level ($p<0.05$).

IV. RESULTS AND DISCUSSIONS

The results from the analysis of the sensory evaluation, proximate composition, anti-nutritional factors, colour determination and rheological properties are presented in Tables 1.

Effect of maturity and drying methods on proximate composition of 'amala' prepared from breadfruit flour

Table 1 shows the result of proximate analysis of amala prepared from both mature and immature breadfruit with three different drying methods (Sun, Oven, and Biomass Fuelled). The carbohydrate content of the reconstituted breadfruit flours for Reconstituted immature sun dried sample (RISDS), Reconstituted immature biomass fuelled dried sample (RIBDS), Reconstituted immature oven dried sample (RIODS) (77.95, 78.26 and 84.30) are higher than those of Reconstituted matured sun dried sample (RMSDS), Reconstituted matured biomass fuelled dried sample (RMBDS), and Reconstituted matured oven dried sample (RMODS) (68.08, 75.45 and 78.03). These results are comparable with previous report (Ragone, 2003) with most figures in agreement with his findings.

The protein content of RMSDS, RMBDS, and RMODS (17.77, 14.50 and 13.82) are higher than those of RISDS, RIBDS, and RIODS (16.44, 12.3 and 7.54) which are better results compared to that of Dignan, *et al.*, (2004) who reported that for the fat content, there is no significant difference when comparing the maturity and the drying methods for biomass fueled dryer and oven (3.45 and 3.67) but for sun dried samples there is significant different in comparing the maturity with the drying method (3.54 and 8.87). The proximate composition of matured and immature breadfruits shows a very significant difference. This trend agrees with earlier report of Akpobome *et al.*, (2003).

TABLE 1: Effect of maturity and drying methods on proximate composition (g/100g) of reconstituted breadfruit flour

Samples	Ash	Crude fibre	Fat	Crude protein	Carbohydrate
RISDS	1.80^{b}±0.05	0.28^{c}±0.09	3.54^{c}±0.01	16.44^{b}±0.01	77.95^{b}±0.13
RMSDS	4.61^{a}±0.10	0.70^{a}±0.10	8.87^{a}±0.11	17.77^{a}±0.05	68.08^{d}±0.06
RIBDS	3.78^{a}±1.77	0.50^{b}±0.18	5.91^{b}±0.16	12.38^{e}±0.03	78.26^{b}±1.71
RMBDS	3.70^{a}±0.16	0.45^{bc}±0.12	5.91^{b}±0.16	14.50^{c}±0.05	75.45^{c}±0.31
RIODS	4.20^{a}±0.11	0.47^{bc}±0.04	3.45^{c}±0.25	7.54^{f}±0.03	84.30^{a}±0.24
RMODS	3.81^{a}±0.04	0.46^{bc}±0.01	3.67^{c}±0.17	13.82^{d}±0.04	78.03^{b}±0.03

Data represent mean ± standard deviation of three replicates, values with different superscripts on a row are significantly different (p<0.05). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted matured sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted matured biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted matured oven dried sample.

Effect of maturity and drying methods on some of the anti-nutritional properties of 'amala' prepared from breadfruit flour

Table 2 shows the effect of maturity and drying methods on some of the anti-nutritional properties in the reconstituted breadfruit flour. The investigation shows a contrast result when compared with the findings of Oladunjoye *et al.*, (2004) on the detection of antinutritional factors in breadfruit meal who reported the presence of phtic acid in breadnut and breadfruit meal respectively.. Tannin also reduces palatability of food. The improvement observed in the metabolizable energy of differently processed meal can be attributed to processing effects on the breadfruits which reduced the level of anti-nutritional factors.(Oladunjoye *et al*., (2010).

The most important observation is that the immature samples has the highest phytate, oxalate and tannin content compared with the matured samples this implies that anti nutrients contents in matured breadfruit are lesser than the immature ones.

Table 2: Effect of maturity and drying methods on some anti-nutritional composition of reconsttuted breadfruit flour

Samples	Phytate(mg/g)	Oxalate(mg/g)	Tannin(mg/g)
RISDS	10.17^{b}±0.46	1.71^{b}±0.00	0.03±0.00
RMSDS	9.55^{b}±0.44	1.26^{d}±0.00	0.02±0.00
RIBDS	12.69^{a}±0.43	1.92^{a}±0.05	0.03±0.00
RMBDS	7.09^{c}±0.43	1.00^{e}±0.00	0.01±0.00
RIODS	9.87^{b}±0.03	1.44^{c}±0.00	0.01±0.00
RMODS	7.42^{c}±0.00	1.00^{c}±0.00	0.01±0.00

Data represent mean±standard deviation of three replicates, values with different superscripts on a row are significantly different (P<0.05). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted matured sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted matured biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted matured oven dried sample.

Effects of Maturity and Drying Methods on Compression and Softness Index of 'Amala' Prepared from Breadfruit Flour.

Table 3a shows the compressive characteristics of the reconstituted breadfruit flours. There is significant difference in the compressive load at break, compressive strain at break, energy at break, extension at break for all the samples. The oven dried samples were able to bear the highest load, strain and energy at break, this is a function of its ability to withstand more load before it ruptures. This may be due to more reduced moisture content during drying.

Table 3b shows the softness index of the reconstituted breadfruit flour, the result shows that there is no significant difference for RMBDS, RIODS and RMODS but difference in RISDS, RMSDS and RIBDS. The softness index of reconstituted breadfruit flour (amala) can be used to simulate 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. Reconstituted breadfruit flour (amala), like many other traditional food gels or dumplings, 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 determine whether such food is swallowable or chewable (Prinz and Lucas, 1995; Szczesniak, 2002). Therefore, lower softness index can predispose the food product towards being masticated or chewed while relative high value encourages swallowability, the oven dried samples have the highest softness index therefore it is the most swallowable.

Table 3a Effect of maturity and drying methods on compression of 'amala' prepared from breadfruit flour.

Samples	Compressive load_at break(N)	Compressive strain_at break (mm/mm)	Energy_at break (J)	Extension_at break (mm)	Modulus (MPa)
RISDS	$58.75^{f}\pm0.01$	$1.89^{e}\pm0.01$	$2.26^{c}\pm0.01$	$-110.30^{b}\pm0.02$	$0.03^{b}\pm0.01$
RMSDS	$69.16^{e}\pm0.01$	$1.99^{c}\pm0.02$	$2.50^{d}\pm0.02$	$-116.40^{e}\pm0.01$	$0.06^{b}\pm0.02$
RIBDS	$74.88^{d}\pm0.02$	$1.94^{d}\pm0.01$	$2.20^{f}\pm0.02$	$-103.50^{a}\pm0.02$	$0.05^{b}\pm0.02$
RMBDS	$79.83^{c}\pm0.03$	$1.99^{c}\pm0.02$	$2.52^{c}\pm0.02$	$-111.30^{c}\pm0.01$	$0.06^{b}\pm0.01$
RIODS	$185.63^{a}\pm0.01$	$2.04^{b}\pm0.01$	$5.17^{a}\pm0.01$	$-112.60^{d}\pm0.02$	$0.12^{a}\pm0.02$
RMODS	$154.35^{b}\pm0.01$	$2.14^{a}\pm0.01$	$3.84^{b}\pm0.01$	$-124.10^{e}\pm0.01$	$0.10^{a}\pm0.02$

Data represent mean±standard deviation of three replicates, values with different superscripts on a row are significantly different ($p<0.05$). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted matured sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted matured biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted matured oven dried sample.

Table 3b: Effect of maturity and drying methods on softness index of 'amala' prepared from breadfruit flour.

SAMPLES	SOFTNESS INDEX
RISDS	$20.01^{d}\pm0.01$
RMSDS	$20.30^{b}\pm0.00$
RIBDS	$20.21^{c}\pm0.00$
RMBDS	$20.41^{a}\pm0.01$
RIODS	$20.41^{a}\pm0.00$
RMODS	$20.41^{a}\pm0.00$

Data represent mean±standard deviation of three replicates, values with different superscripts on a row are significantly different ($p<0.05$). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted matured sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted matured biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted matured oven dried sample.

Effect of maturity and drying methods on colour of 'amala' prepared from breadfruit flour

Table 4 shows the effect of maturity and drying methods on colour of amala prepared from breadfruit flour. Sample RISDS and RMSDS has the highest L* values (60.05 and 60.02) followed by RIBDS and RMBDS (59.40 and 59.20), RIODS and RMODS has the lowest (58.62 and 58.71). This shows that the reconstituted immature and matured sun dried samples were lighter in colour compared with biomass fuelled dried samples and oven dried samples this may be due to the drying method used, this findings was similar to that reported by (Krokida *et al.*, 1998). Generally, there was a change of colour when flour was reconstituted to produce *amala* as compared with the colour of flour and corresponding pastes. This is in agreement with the earlier finding of Akissoe *et al., (*2001).

Table 4: Effect of maturity and drying methods on colour of reconstituted breadfruit flour

Samples	L*	a*	b*	Chroma	Hue angle	Brown Index (100-L*)
RISDS	$60.05^{a}\pm0.01$	$46.37^{f}\pm0.02$	$12.49^{a}\pm0.02$	$48.01^{f}\pm0.01$	$15.07^{a}\pm0.02$	$39.95^{d}\pm0.01$
RMSDS	$60.02^{b}\pm0.01$	$46.49^{e}\pm0.01$	$12.45^{b}\pm0.02$	$48.13^{e}\pm0.01$	$15.00^{b}\pm0.02$	$39.97^{d}\pm0.01$
RIBDS	$59.40^{c}\pm0.02$	$47.51^{d}\pm0.02$	$12.33^{c}\pm0.02$	$48.80^{d}\pm0.02$	$14.60^{c}\pm0.03$	$40.60^{c}\pm0.02$
RMBDS	$59.20^{d}\pm0.02$	$47.51^{c}\pm0.02$	$12.24^{d}\pm0.01$	$49.06^{a}\pm0.02$	$14.45^{d}\pm0.02$	$40.80^{b}\pm0.02$
RIODS	$58.62^{f}\pm0.02$	$49.22^{a}\pm0.02$	$12.15^{e}\pm0.02$	$50.69^{a}\pm0.02$	$13.81^{f}\pm0.02$	$41.26^{a}\pm0.22$
RMODS	$58.71^{e}\pm0.02$	$48.25^{b}\pm0.02$	$12.05^{f}\pm0.02$	$49.73^{b}\pm0.01$	$14.50^{e}\pm0.02$	$41.28^{a}\pm0.02$

Data represent mean ± standard deviation of three replicates, values with different superscripts on a row are significantly different ($p<0.05$). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted matured sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted matured biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted matured oven dried sample.

Effect of Maturity and Drying Methods on Sensory Properties of 'Amala' Prepared From Breadfruit Flour.

Immature and matured reconstituted breadfruit flour using different drying methods were subjected to sensory evaluation for colour, taste, odour, texture and overall acceptability. The result is shown in Table 5. Although all the samples were accepted, sample RMSDS and RIODS were the most acceptable. The high scores (7.00) was considered to be due to its excellent texture and colour, while RIBDS was least preferred.

Table 5: Effect of maturity and drying methods on sensory qualities of reconstituted breadfruit flour (amala)

Samples	Colour	Texture	Aroma	Taste	Overall acceptability
RISDS	$6.00^{a}\pm1.32$	$6.44^{a}\pm1.01$	$5.11^{ab}\pm1.54$	$7.11^{a}\pm1.05$	$6.44^{ab}\pm0.53$
RMSDS	$6.44^{a}\pm1.33$	$6.11^{a}\pm1.36$	$6.44^{a}\pm1.59$	$6.22^{ab}\pm1.09$	$7.00^{a}\pm 0.50$
RIBDS	$6.33^{a}\pm1.32$	$5.89^{a}\pm1.05$	$5.65^{ab}\pm1.50$	$4.56^{cd}\pm1.15$	$5.78^{c}\pm0.67$
RMBDS	$5.58^{a}\pm1.27$	$6.56^{a}\pm1.13$	$5.11^{ab}\pm1.54$	$4.11^{d}\pm1.54$	$6.00^{bc}\pm0.50$
RIODS	$6.44^{a}\pm1.13$	$6.33^{a}\pm1.00$	$6.22^{ab}\pm1.00$	$6.11^{ab}\pm1.96$	$7.00^{a}\pm0.71$
RMODS	$5.78^{a}\pm1.20$	$6.78^{a}\pm1.09$	$4.89^{b}\pm1.36$	$5.56^{bc}\pm0.88$	$5.89^{bc}\pm0.78$

Data represent mean±standard deviation of three replicates, values with different superscripts on a row are significantly different ($p<0.05$). RISDS - Reconstituted immature sun dried sample. RMSDS - Reconstituted mature sun dried sample. RIBDS- Reconstituted immature biomass fuelled dried sample. RMBDS – Reconstituted mature biomass fuelled dried sample. RIODS – Reconstituted immature oven dried sample. RMODS – Reconstituted mature oven dried sample.

V. CONCLUSION

One major factor limiting availability of breadfruit is its poor storability, as the fruits undergo rapid physiological deterioration after harvesting. One way to minimize post-harvest losses and increase the utilization of breadfruit is through processing into flour, which is a more stable intermediate product. The flour can then be the starting material for processing through reconstitution with hot water to form a paste (Amala).

From the result of proximate composition, amala prepared from breadfruit is a rich source of protein, fat and carbohydrate, the matured breadfruit has the highest protein and fat contents when comparing maturity and drying methods. For sensory evaluation, matured sun dried and oven dried samples were the most acceptable.

From the result of present study, reconstitution improves the nutritional quality and has little effect on softness index on the breadfruit. It does not increase only the protein, fat and sensory qualities but also decrease the anti-nutritional contents of breadfruit.

For production of high quality breadfruit flour, biomass drying of matured fruits is recommended because of its high protein content and low anti-nutritional factors though sun dried sample has higher protein content but past research works showed that sun drying method is susceptible to high microbial load.

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