Quality Characteristics of Acha-Rice Bran Flour Blend and Biscuits

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Abstract

The quality characteristics of flour and biscuits prepared from acha and rice bran flour blends were investigated. The functional, pasting, phytochemical, physical, proximate and sensory properties of the flour blends and composite biscuits were determined. The result showed that AFR4 (80AF%:20RB %) flour had the highest water absorption capacity 2.94g/g, oil absorption capacity 1.50g/g, bulk density 1.05g/ml and low in foaming capacity 1.31g/g. The pasting properties of the flour was determined and the peak viscosity increased with addition of rice bran to the flour, it ranged from (4729.30-4777.90), the trough viscosity, final viscosity, setback increased upon the addition of rice bran. Sample AFR4 (80AF%:20RB %) had the highest oxalate (0.82 mg/100g) and also had the least phytate 1.20mg/100g, phenols 0.80mg/100g and tannin1.36mg/100g. The result showed that the spread ratio and break strength of the biscuit decreased from (5.50-5.23) and (0.80-0.61kg) respectively. The result indicated that AFR4 (80AF%:20RB %) had the highest protein (8.80%), fat (18.70%) and energy (1819.04 kJ), ash (3.08%), moisture content (4.76%) and crude fibre (2.30%).There was a significant difference ($P<0.05$) among the samples. The average means scores of the colour and taste decreased from 7.85 to 5.90 and 7.45 to 5.35 respectively with increase in the percentage (0-20%) of the added rice bran flour, the average means scores of the crispiness and odour also decreased from 7.15 to 6.50 and 6.75 to 7.05 respectively with increase in the supplementation of rice bran flour from 0-20%. However, the average means scores for the mouthfeel increased from 5.65 to 7.35 with increase in rice bran flour supplementation (0 -20%) and the control 100% acha was the preferred sample (7.00) in terms of general acceptability. Furthermore, it is worthy to note that as level of substitution of acha with rice bran increased, the functional, phytochemical, pasting properties and proximate composition of composite flour blends and biscuits was improved.

Keywords: Quality, Characteristic, Acha-rice bran, flour, biscuits

Introduction

Acha (*Digitariaexillis*) is a cereal grain in the family of gramineae and commonly referred to as fonio or hungry rice (Alamu, 2001;Jideani 1999 ; NRC 1996). The grain is grown in areas with at least 800mm of rainfall such as the mountain Fouta Dyallon region of Guinea and dry Savanna zone of Mali and upper Volra (Lasekan, 1994). The major traditional foods from the grain are: thick (tuwo) and thin (kunu), porridge, steamed product (brabusco or couscous) and alcoholic beverages (Jideani and Akingbala, 1993; Jideani and Jideani 2011). Acha grains may be boiled like rice; flour from acha may be fortified with other cereals flour especially for the production of porridge or pudding (Ayo and Nkama, 2003; Ayo and Nkama 2006). Acha grain can also be milled into flour to produce biscuit and bread with desirable qualities (Ayo and Nkama, 2003; Alain *et al*., 2007).

Acha can be classified based on the color and sizes of the grain. Acha is also one of the most nutritious of all grains; its seed is rich in methionine and cystine which are vital to human health and deficient in today's major cereals like wheat, rice, maize, sorghum, barley and rye (Jideani and Akingbala, 1993; Ayo and Nkama 2006). The consumption of cereal based foods like biscuit has triggered required development of an adequate substitute for wheat (Ayo and Nkama, 2003;Jideani et al 2000). Acha is also known for its nutritional properties although the protein content of acha is similar or slightly lower than that of other grains, it contains amino acid like methionine and cysteine which are essential for human health which are often deficient in today's major cereals. Acha is known to be easy to digest, it is traditionally recommended for children, old people and for people suffering from diabetes or stomach diseases. Acha does not contain any glutenin or gliadin proteins which are the constituents of gluten, making this cereal suitable for people with gluten intolerance (Harlan, 1993). Acha has the potential to contribute significantly to whole grain diets, wellness, economic status improvement, and could play an important role in food security in developing economy of a nation like Nigeria.

Rice is one of the most commonly consumed cereal in Nigeria. Large amount of by products are obtained as waste during the processing of rice. This is a problem to the cereals processing industries and pollution monitoring agencies. However, rice bran is rich in essential minerals, fibers and phytochemicals with health benefits(Yadav and Yardav 2011). The potential food applications of rice bran have not been fully exploited. Acha flour which is could be used for biscuit production is generally low in dietary fibre, micronutrients and phytochemicals and this makes biscuit and its food products not a wholesome diet. Rice bran can be processed into flour and used to supplement biscuit for its dietary fibre and essential phytochemical (Singh *et al* 2013).

Using rice bran in production of products such as biscuit could be a way of adding value to rice bran which is regarded as waste. In addition, substituting acha flour with rice bran could provide a product that may be more suitable and cardiovascular disorder with reference to previous studies potentials of rice bran and its benefits to human health . These health benefits includes :- prevention of cancer, asthma, arthritis high blood pressure (Or *et al* 1981). Rice bran is relatively high in protein, contains reasonable quantity of antioxidants such as tocopherols, tocotrienol, gamma-oryzanol Zha *et al* 2009).

Acha has been identified as a major food for diabetic patients in Nigeria, by medical practitioners (Jideani, 1991). It is of great interest to develop acha biscuit that will be of great benefit to teaming number of diabetic patients in Nigeria. The fortification of acha flour with rice bran can improve nutritional value of acha based products such as biscuits. This research work is aimed at accessing the effect of rice bran substitution on the quality of acha flour and acha biscuits.

MATERIALS AND METHOD

The creamy colored Acha grains (*Digitaria exilis*) were purchased from a local market in Jos, Plateau State while rice bran were procured from Miva rice mill Makurdi Benue State. Baking powder, baking fats, salt and sweet potato were purchased from Gboko main market, Benue State.

Preparation of Raw Materials

Acha flour: The *acha* was manually cleaned by handpicking of the chaff and the dust and stones were removed by washing in clean water (sedimentation) using local calabash. The washed and de-stoned grains were sun dried and then milled using attrition milling machine (model R175A). The flour was sieved (0.3mn aperture), packaged (polyethylene) and stored under room temperature.

Rice bran flour: The rice bran was cleaned, milled using attrition milling machine (model R175A). The flour was sieved (0.3mn aperture), stabilized at 120°C for 10 minutes and then packaged (polyethylene) and stored under room temperature till it was needed for analysis.

Formulation of blends

Acha and rice bran flours were blended at different proportions at (100:0; 95:5; .90:10; 85:15 and 80:20%) respectively in order to prepare the composite flours. 100% acha flour served as control (Table1). The blends were thoroughly mixed and kept in plastics containers until needed.

Production of acha- rice bran biscuits

Biscuits were prepared from the acha and rice bran blends and 100% acha (Table 1). The method of Ayo and Nkama (2003) was used in the biscuit production. Sweet potato flour and fat were mixed using a Kenwood mixer at medium speed until light and fluffy. Flour was added to the mixture followed by water, salt and baking powder. The mixture was thoroughly mixed into consistent dough. The dough was filled and pressed out into predetermined size and shape using a piping bag. The dough was arranged in pre-oiled trays and baked in a preheated laboratory oven operating at 175°C for (20-30min). After baking, the hot biscuits were removed from the pan and placed on a clean tray to cool down. The biscuits were then packed after cooling in polyethylene sachets of appropriate thickness and permeability using an impulse sealing machine prior to further analysis.

Functional Properties

Water Absorption Capacity

The method of Gomez *et al.*,(1997) was adopted in the determination of water absorption capacity. One (1g) gram of sample was weighed into a conical graduated centrifuge tube and thoroughly mixed with 10ml distilled water for 30seconds using a warring whirl mixer. The sample was then allowed to stand for 30 minutes at room temperature and then centrifuged at 5,000rpm for 30 minutes. The volume of free water (supernatant) was read directly from the graduated centrifuge tube.

Absorption capacity is expressed as grams of water absorbed (or retained) per gram sample.

Water absorption capacity = Amount of water absorbed (total-free) x density (water).

Oil Absorption Capacity

The method of Gomez *et al.*,(1997) was adopted in the determination of oil absorption capacity. One (1g) gram of sample was weighed into a conical graduated centrifuge tube and thoroughly mixed with 10ml of oil for 30seconds using a warring whirl mixer. The sample was then allowed to stand for 30 minutes at room temperature and then centrifuged at 5,000rpm for 30 minutes. The volume of free oil (supernatant) was read directly from the graduated centrifuge tube.

Absorption capacity is expressed as grams of oil absorbed (or retained) per gram sample.

Oil absorption capacity = Amount of oil absorbed (total-free) x density (oil)

Emulsifying Capacity

The method of Gomez *et al.*, (1997) was adopted in the determination of emulsifying capacity. Two (2g) gram of the flour sample was blended with 25ml distilled water at room temperature for 30seconds in a warring blender at 1600rpm. 25ml of vegetable oil was gradually added after complete dispersion with continued blending for another 30seconds, then transferred into a centrifuge tube at 1,600rpm for 5minutes. The volume of oil separated from the sample after centrifuging is read directly from the tube.

Emulsion capacity is expressed as the amount of oil emulsified and held per gram of sample.

$$\text{Emulsion Capacity} = \frac{X}{Y} \times \frac{100}{1}$$

Where X = height of emulsified layer

Y = height of whole solution in the centrifuge tube.

Bulk Density

The method of Gomez *et al.*, (1997) was adopted in the determination of bulk density.Bulk densities of samples were determined by weighing 25ml capacity graduated measuring cylinder, gently filling the cylinder with the sample and tapping the bottom of the cylinder on the laboratory bench several times until there is no further diminution of the sample level after filling the 25ml mark. The final volume is expressed as g/ml.

The bulk density (g/ml) = Weight of sample

Volume of sample (ml)

Foam Capacity

The method of Onwuka (2005) was adopted in the determination of foam capacity. From the powdered sample, 2.00 g were weighed, blended with 100 cm3 of distilled water using blender and the suspension was whipped for 5 min. The mixture was then poured into a 100 cm3 measuring cylinder and its volume was recorded after 30 s. Foam capacity was expressed as percent increase in volume using the formula

Volume after whipping − volume before whipping Foam capacity = × 100 Volume before whipping.

Pasting Properties

Pasting characteristics were determined using a Rapid Visco Analyzer (Model RVA 3D+. Newport Scientific Australia). 2.5g of the sample was weighed into a previously dried canister and 25 ml of distilled water was dispensed into the canister containing the sample. The suspension was thoroughly mixed and the canister was fitted into the Rapid ViscoAnalyser as recommended. Each suspension was kept at 50°C for 1min and then heated up to 95°C with a holding time of 2min followed by cooling to 50°C with 2min holding time. The rate of heating and cooling were at a constant rate of 11.85°C per min. Peak viscosity, trough, breakdown, final viscosity, set back, are read from the pasting profile with the aid of thermocline for windows software connected to a computer (Newport scientific 1998).

Phytochemical Determination

The oxalate was determined using the method described by AOAC (2010), while the phytate, Tannin and phenol was determined using the method of (Obadoni and Ochukwu, 2001).

Physical Analysis

Spread Ratio: The Spread Ratio was determined by measuring the length and height of three rows and column, respectively of five well-formed biscuits. The spread ratio was calculated as diameter divided by height (Gomez *et al.*, 1997).

Break Strength: The break strength was determined by adapting Okaka and Isieh's (1997) method. Biscuit of known thickness (0.4cm) was placed centrally between two parallel metal bars (3cm apart). Weights were added on the biscuit until the biscuit snapped. The least weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit.

Proximate Analysis

The protein, fat, ash, crude fibre and moisture content of the samples were determined using AOAC (2012) method. The carbohydrate content was determined by simple difference: CHO = 100 – (% moisture + % protein + % fat + % ash) using.

Sensory Evaluation

The sensory evaluation of the samples was carried out for consumer acceptance and preference using randomly selected 20 untrained judges (students and staff of the Department of Food Science and Technology, University of Mkar, Benue State, Nigeria). The panelist were instructed to evaluate the coded samples for colour, crispiness, flavour, taste, texture, mouth feel and general acceptability. Each sensory attribute was rated on a 9-pointHedonic scale (1= dislike extremely and 9=like extremely). The panelist were offered distilled water to rinse their mouth between evaluations(state the reference)

Statistical Analysis

The results obtained from the various analyses were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 20.0. Meanswere separated with Duncan Multiple Range Test (DMRT) at 95% confidence level ($p \leq 0.05$).

Results and Discussions

Functional properties of flour blends

The result of functional properties of flour blends is presented in Table 1 . The Water absorption capacity ranged from 2.33g/g (for 100% acha flour) to 2.94g/g (for 80AF: 20RB% blend). Significant differences ($P < 0.05$) exist among samples. Water absorption capacity increased with addition of rice bran flour (0-20%). The increase may be due to the proportion of hydrophilic amino acid present in the protein. The result obtained is higher than those reported by Singh *et al.,* (1991). Adepeju *et al.* (2014) reported that elevated water hydration ability is advantageous in food structure to get better yield and uniformity of food product. This is in agreement with the finding of Satina *et al.* (2011) and Adeleke and Oladeji 2010..

The oil absorption capacity of flour blends ranged from 0.84g/g (for 100% acha flour) to 1.50g/g (for 80AF: 20RB% blend). The oil absorption capacity increased with addition of rice bran flour (0-20%). This means that rice bran can be used to improve oil absorption of a material. Hutton and Campbell (1981) reported that the ability of food to absorb oil may help to enhance flavor retention and mouthfeel.

The emulsion capacity of the flour blends ranged from 50.87% (for 100% acha flour) to 58.97 (for 80AF: 20RB% blend). The result revealed that there was an increase in emulsion capacity with addition of rice bran (0-20%). There was a significant difference ($p < 0.05$) among samples. Due to high emulsion properties of formulated flour from rice bran and acha flour, it can be used as additives for the stabilization of emulsions.

The bulk density ranged from 0.96 g/ml (for 100% acha flour) to 1.05g/ml (for 80AF: 20RB% blend). The result revealed that the bulk density increased upon addition of rice bran flour where higher values were recorded (0-20%). The bulk density differ significantly ($p < 0.05$) among the samples. The values are higher than that reported by Satinar *et al.* (2011) for defatted rice bran.

The foaming capacity varied between 1.31v/v (for 100% acha flour) to 2.20v/v (for 80AF: 20RB% blend). The result showed that there was a decrease in the foaming capacity with increase in rice bran flour (0-20%). The sample was significantly different ($p<0.05$). The foaming capacities were less compared with result reported by Oshodi *et al., (*1999). Ekasit *et al.* (2010) associated good foaming capacity with flexible protein molecules which is easily denatured and reduces surface tension. This implies that protein in rice bran flour is a highly ordered globular protein which is not easily denatured. Formulated sample cannot be used in aerating products such as cake, chipped toppings.

Pasting Properties of Acha and Rice Bran Flour Blends.

The result of pasting properties of flour blends is presented in Table 2. The peak viscosity value ranged from 4729.20 (for 100% acha flour) to 4777.90RVU (for 80AF: 20RB% blend). The peak viscosity of flour blends increased with increasing level of rice bran flour. Peak viscosity is the highest thickness reached during or after the cooking of the sample. The sample differed significantly ($P > 0.05$). Peak viscosity is the capacity of the starch to rise up prior to its physical breakdown (Sanni *et al.,* 2004). High peak viscosity gives the water holding power of a material and takes place at stable point during swelling, thereby leading to rise in thickness(Kin *et al.,* 1995).

The trough viscosity value ranged from 1728.70RVU(for 100% acha flour) to 2072.14RVU(for 80AF: 20RB% blend). The trough viscosity of flour blends increased with increasing level of rice bran flour. There was significant difference ($P> 0.05$) among the samples. Trough thickness measures the smallest capacity of the paste to resist collapse during the period of cooling Adegunwa *et al.,* (2011). The value is greater than the value reported by Appiah *et al.,* (2011).

The breakdown value ranged from 2705.71(for 80AF: 20RB% blend) to 3000.63RVU(for 100% acha flour). The breakdown viscosity of flour blends decreased with increasing level of rice bran flour. Significant difference ($P > 0.05$) was observed in all the samples. The breakdown viscosity shows the stability of cooled starch. Breakdown is a measure of susceptibility of cooled starch granules to disintegrate (Beta *et al.,* 2003). Generally, the breakdown viscosity is low which suggest that all the samples are more stable and has high resistance to retro gradation, syneresis or weeping, cooling or paste stability.

The final viscosity value ranged from 3456.40(for 100% acha flour) to 4095.60RVU (for 80AF: 20RB% blend). There was Significant difference ($P > 0.05$) among samples. The final viscosity of flour blends increased with increasing level of rice bran flour. Final viscosity shows the capacity of a sample to yield a gel or thick paste upon cooling or cooking in opposition to the paste due to shear stress during mixing Adebowale *et al.,* (2005).

The setback value ranged from 1727.74 (for 100% acha flour) to 2023.43RVU(for 80AF: 20RB% blend). The setback value differ significantly (P > 0.05) between the samples. Setback viscosity of flour blends increased with increasing level of rice bran flour. Setback is a stage in pasting profile that is related to the re-association of starch after cooking (Kin *et al.,* 1995).

The pasting time values ranged from 9.25 to 8.22 minutes. The highest value was observed in the 100% acha flour while sample 95AF: 5 RB had the least value. The sample differ significantly (P > 0.05)

Pasting temperature ranged from 90.20 to 86.40^{0}C. Significant difference (P > 0.05) existed among the samples. Pasting temperature gives the lowest temperature needed to cook a sample, cost of energy involved and other component firmness.

Phytochemical Properties of Flour blends.

The phytochemical contents of flour blends are presented in Table 3. The phytate acid content of samples ranged from 1.20mg/100g (for 80AF: 20RB %) to 1.75mg/100g (for 100% acha flour). The phytic acid value decreased significantly (P > 0.05) with an increase in rice bran substitution level. Phytic acid is an anti-nutrient in foods. Satinder *et al.* (2011) reported low phytate content for rice bran, followed by wheat bran and barley bran. Therefore, the low content of phytate observed could be contributed by rice bran flour.

The phenol content of samples ranged from 0.80mg/100g (for 80AF: 20RB %) to 1.07mg/100g (for 100% acha flour). Statistically, significant difference (p > 0.05) did exist between the samples. The value are lower than the value reported by Satinder *et al.* (2011) for rice bran. The trace quantities of phenolic compounds indicate that the sample could act as immune enhancers, hormone modulators, antioxidant, anti-clothing and anti-inflammatory Okwu and Omodamoro (2005; Jiang and Wang 2005)

The tannin content of samples ranged from 1.20mg/100g (for 80AF: 20RB %) to 2.10mg/100g (for 100% acha flour). The tannin content decreased with an increase in rice bran substitution level. However, there was significant difference (p > 0.05) among the samples. Satinder *et al.* (2011), reported lower value of tannin for wheat bran, rice bran, oat bran and the value reported by Okwu and Ndu (2006) is lower than the value reported for this work. Tannins have been reported to speed up the rate of healing in enlarged mucous membrane, to be quick in curing of wounds and to possess astringent properties. The presence of tannin in the flour will support their use in treating hemorrhoid, varicose ulcers, frostbite, burns in herbal medicine and wound Okwu and Okwu (2004).

The oxalate content of samples ranged from 0.33mg/100g (for 100% acha flour) to 0.82mg/100g (for 80AF: 20RB %). There was a significant difference (p> 0.05) among the samples. The result indicates that supplementing acha flour with rice bran increased the oxalate content (0-20%). High oxalate has been reported by Satinder *et al.* (2011) for rice bran, followed by wheat bran and oat bran. The result suggests that acha flour fortified with rice bran would supply a constant intake of oxalate. The elevated oxalate content in formulated flour than in polished cereal grain implies that oxalic acid is mostly situated in the surface covering of grains cereal(Satinder *et al.* 2011; Jariwalla 2001). However, the study reveals that acha and rice bran blended flour can be consumed even by patients suffering from kidney stone. This is because the value is far below the daily recommended intake not to go above 50 – 60 mg/day (Chicago Dietetic Association, (2000)

Physical properties of biscuits

There was a decreasing trend in the spread ratio of biscuit with the proportionate increase of supplementation (0-20%)asshown in Table 4. The spread factor of biscuit, prepared from acha and rice bran flour ranged from 5.23-5.50. The maximum value (5.50) for spread ratio was observed in the control (biscuit with 0 percent rice bran) whereas minimum (5.23) in biscuit prepared from 20% rice bran supplementation. These results agreed are in accordance with the findings of Sharif *et al.* (2009) who reported that spread factor of rice bran supplemented biscuits decreased with the increasing level of rice bran. Significant difference (P < 0.05) did exist between the samples Sharma and Chauhan (2002) also reported that physical properties of biscuit like width, thickness and spread factor were affected significantly with the increase in the level of bran and also by method of stabilization. (Sekhon*et al.,*1997) also reported that biscuit spread progressively decreased with an increase in the level of both laboratory and commercially defatted brans.

The break strength ranged between 0.61kg and 0.80kg. The break strength of the biscuit decreased with increase in supplementation of the rice bran flour (0-20%). Significant difference (p < 0.05) did exist between the samples.The use of composite flour for biscuit making has been reported by (Okaka and Isieh1990) and (Ayo *et al.,* 2007) to reduce its break strength which agrees with the result of this study. The reduction could be due to carbohydrate/starch of rice bran flour which may not be as hard/strong like that of acha flour.

Proximate composition of biscuits

The proximate composition of biscuits prepared from acha and rice bran flour blends are presented in Figure 1. The protein content of biscuits ranged from 7.85 (for 100% acha biscuits) to 8.80 (for 80AF: 20RB% biscuits). The protein content of biscuits increased with an increase in rice bran substitution level. The values indicate that significant difference (p > 0.05) exists among the samples. High protein content has been reported by (AbdEl-Galeel and EL-Bana 2012); (Rosniyana*et al.,*2007); (Hu *et al.,* 2009; Olapade *et al* 2012; Ayo and Kajo 2016) for substitution of rice bran. Therefore, the increase in incorporation of rice bran flour into acha flour to produce biscuit could improve the protein value of a product produced from the flour which could be an advantage in the production of weaning foods.

Moisture content ranged from 4.08% (for 100% acha biscuits) to 4.76% (for 80AF: 20RB% biscuits). The effects of the added rice bran were significant (p > 0.05). The moisture content of the biscuits increased with increase in rice bran substitution level and this increase may be due to the proportion of hydrophilic amino acid present in the protein. Relative low moisture content suggest that the biscuit could have a good storage potential(Ayo and Nkama 2006). The moisture and water activity of a product determine greatly the keeping quality of the food.

Fat content ranged from 17.63(for 100% acha biscuits) to 18.70 (for 80AF: 20RB% biscuits). Fat content of the biscuit increased with increment in rice bran substitution levels.The effects of the added rice bran were significant (p > 0.05).The value range agreed with works of Idouraine *et al.(*1996); Rosniyana *et al., (*2007); Rosniyana *et al.,(*2009) who attributed the elevated lipid to the presence of clustered aleuronic layers with oil in the rice bran which are not separated mostly at the first stage of milling.

Ash increased from 1.60(for 100% acha biscuits) to 3.08 %(for 80AF: 20RB% biscuits)and effect are significant (p > 0.05). Ash content of the biscuits increased with an increase in rice bran substitution levels. The value reported agreed with the report of (Abd-EL-Galeel and EL-Bana, 2012) and (Rosniyana *et al.* 2009) and (Adebayo *et al.* 2012). High value of ash content suggests high minerals in the biscuits with rice bran.

The carbohydrate content of biscuits ranged from 63.03 (for 100% acha biscuits) to 69.02% (for 80AF: 20RB% biscuits). The carbohydrate content of biscuits decreased with increase in rice bran substitution levels and the effect is significant, (p>0.05).It could be observed that the carbohydrate present in rice bran is from the starch endosperm, ridges and broken pieces resulting from the final milling operation to remove the final traces of bran layers as well as kernel endosperm (Lloyd *et al.,* 2000). The reduction observed is in agreement with the report of Jimoh and Olatidoye (2009). The energy value of blended flour ranged from 1792.71(for 100% acha biscuits) to 1819.04 kJ(for 80AF: 20RB% biscuits). The energy differ significantly (P <0.05) among the samples. Energy was observed to be elevated in the entire formulation and increased with increased level of rice bran substitution.

The total dietary fibre increased from 1.64(for 100% acha biscuits) to 2.30%(for 80AF: 20RB% biscuits) with an increase in rice bran substitution levels. The effects of the added rice bran were significant (p > 0.05). Essential health profits linked with optimal ingestion of dietary fibre comprises decreased coronary heart diseases, decreased risk of developing type

2 diabetes, better satiety and stool bulking (Buttriss and Stokes, 2008; Kendall *et al.,* 2010, Ayo and Kajo 2016). The result is relatively lower than that reported by (Damayanthi, 2001; Qureshi et al 2002). The addition of rice bran increased fibre content.

Sensory properties of biscuits

The sensory properties of biscuits prepared from acha and rice bran flour blends is presented in Figure 2. The average mean scores for the colour ranged from 5.90 (for 80AF: 20RB biscuit) to 7.85 (for 100% acha biscuits). Colour score decreased with an increase in rice bran substitution level. The effects of the added rice bran were significant ($p > 0.05$).These results are in agreement with the findings of Sudha *et al.* (2007) that reported that progressive increase in supplementation level of rice bran produced progressively darker biscuits and this is due to the inherent dark color of rice bran flour.

The average mean scores for the crispness ranged from 6.50 (for 80AF: 20RB biscuit) to 7.15 (for 100% acha biscuits). Crispiness score decreased with an increase in rice bran substitution level and the samples differed significantly ($p > 0.05$). The crispiness decreased due to the reduced network of the acha flour and thus reduction in the gustatory sensation of brittleness.

The average mean scores for the taste ranged from 5.90(for 80AF: 20RB biscuit)to 7.45(for 100% acha biscuits). Taste score decreased with an increase in rice bran substitution level and the samples differed significantly ($P>0.05$). The decrease in taste is due to the bitter flavour produced by lipolytic enzymes in the oil of rice bran.These results are in agreement with the findings of (Carroll 1990).

Odour score ranged from 5.35 (for 80AF: 20RB biscuit)to 6.75 (for 100% acha biscuits). Odour score decreased with an increase in rice bran substitution level and the samples differed significantly ($P>0.05$)These results are also in conformity with the findings of Sharma and Chauhan (2002) who reported that odour decreased with increase in the level of bran in the biscuit.

The average mean scores for the texture ranged from 6.10 (for 80AF: 20RB biscuit) to 6.75 (for 100% acha biscuit). Texture score decreased with an increase in rice bran substitution level and the sample differed significantly ($P<0.05$) and this decrease could be due to the limited smoothness of the rice bran flour (Murillo *et al* 2011; Faris and Singh 1990).

The average mean scores for the mouth feel ranged from 5.65 (for 100% acha biscuits) to 7.35 (for 80AF: 20RB biscuit). Mouth feel increased with an increase in rice bran substitution level and sample differed significantly ($P>0.05$) and this increase is due to the ability of rice bran flour to absorb oil which helps to enhance mouth feel and flavor retention (Hutton and Campbel1981).

General acceptability score ranged from 6.15 (for 100% acha biscuits) to 7.00 (for 80AF: 20RB biscuit). General acceptability decreased with an increase in rice bran substitution level and sample differed significantly ($P>0.05$).

Conclusion

This study was undertaken to evaluate the effect of rice bran substitution on acha flour and its effects on the quality characteristics of the flour and biscuits. The inclusion of rice bran has improved the quality of acha biscuit particularly the fibre, ash(mineral content) content and the sensory quality most especially the crispness of the acha biscuit.

It is recommended that other cereal such as oat maize, sorghum, barley and rye could be used as alternative to acha flour to add value their respective food products . Further work could include evaluation of the digestibility and micro nutrients of their blends.

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Table 1:. Functional Properties of Acha and Rice Bran Flour blends.

Flour Blends	AF:RBF (%)	WAC (g/g)	OAC (g/g)	EC (%)	BD (g/ml)	FC (v/v)
AFR	100:0	2.33^{c}±0.30	0.84^{c}±0.10	50.87^{e}±0.63	0.96^{b}±0.05	2.20^{a}±0.30
AFR1	95:5	2.60^{b}±0.03	1.00^{c}±0.09	53.75^{d}±0.25	1.01^{ab}±0.03	2.00^{ab}±0.00
AFR2	90:10	2.63^{b}±0.03	1.10^{bc}±0.20	56.03^{c}±0.35	1.03^{a}±0.02	1.68^{bc}±0.27
AFR3	85:15	2.75^{ab}±0.05	1.30^{ab}±0.20	57.08^{b}±0.24	1.04^{a}±0.03	1.52^{cd}±0.20
AFR4	80:20	2.94^{a}±0.05	1.50^{a}±0.14	58.97^{a}±0.11	1.05^{cd}±0.02	1.31^{d}±0.36

Means are values of triplicate determinations. Values with the same superscript within a column are significantly same ($p<0.05$) level
WAC = water absorption capacity; OAC = oil absorption capacity; EC = emulsifying capacity; BD = bulk density; FC = foaming capacity

Table 2: Pasting Properties of acha –rice bran flour blends.

Acha Flour (%)	Rice -bran flour (%)	Peak Viscosity (cp)	Trough Viscosity (cp)	Breakdown Viscosity (cp)	Final Viscosity (cp)	Setback Viscosity (cp)	Pea k Time (mins)	Peak Temp (°C)
100	0	4729.30 ^{c}±7.60	1728.70 ^{d}±7.90	3000.63 ^{a}±0.20	3456.40 ^{e}±22.08	1727.74 ^{d}±0.10	9.25 ^{a}±0.50	87.50 ^{b}±0.21
95	5	4739.20 ^{bc}±0.10	1844.80 ^{c}±1.43	2894.36 ^{b}±1.74	3659.40 ^{d}±22.73	1814.60 ^{c}±2.44	8.22 ^{c}±0.01	87.20 ^{b}±0.70
90	10	4745.10 ^{b}±0.10	1860.40 ^{b}±8.20	2884.64 ^{b}±0.10	3782.30 ^{c}±7.00	1921.81 ^{b}±1.04	8.32 ^{c}±0.30	90.20 ^{a}±0.21
85	15	4768.14 ^{a}±1.70	2063.30 ^{a}±1.20	2704.82 ^{c}±1.83	4022.62 ^{b}±1.40	1959.32 ^{b}±1.12	8.60 ^{b}±0.07	86.75 ^{b}±1.06
80	20	4777.90± ^{a}4.60	2072.14 ^{a}±0.10	2705.71 ^{c}±1.44	4095.60 ^{a}±4.14	2023.43 ^{a}±0.13	9.20 ^{a}±0.14	86.40 ^{b}±0.42

Table 3: Phytochemical Properties of acha – rice bran Flour blends

Acha Flour (%)	Rice-bran Flour (%)	Phytate (mg/100g)	Phenols (mg/100g)	Tannins (mg/100g)	Oxalate (mg/100g)
100	0	1.75[a]±0.03	1.07[a]±0.02	2.10[a]±0.01	0.33[d]±0.02
95	5	1.68[b]±0.00	0.94[b]±0.01	1.74[b]±0.02	O.40[d]±0.02
90	10	1.43[c]±0.02	0.93[b]±0.01	1.62[c]±0.02	0.60[c]±0.03
85	15	1.30[d]±0.00	0.86[c]±0.01	1.30[d]±0.00	0.73[b]±0.01
80	20	1.20[e]±0.02	0.80[d]±0.01	1.20[e]±0.02	0.82[a]±0.02

Means are values of triplicate determinations. Values with the same superscript within a column are significantly same ($p<0.05$) level

Table 4:.Physical Properties of acha –rice flour blend Biscuits

Acha Flour (%)	Rice-bran Flour (%)	Spread ratio	Breakstrength (kg)
100	0	5.50[a]±0.01	0.80[a]±0.01
95	5	5.42[b]±0.01	0.80[b]±0.00
90	10	5.30[c]±0.01	0.76[c]±0.01
85	15	5.30[d]±0.01	0.73[d]±0.00
80	20	5.23[e]±0.01	0.61[e]±0.01

Means are values of triplicate determinations. Values with the same superscript within a column are significantly same ($p<0.05$) level

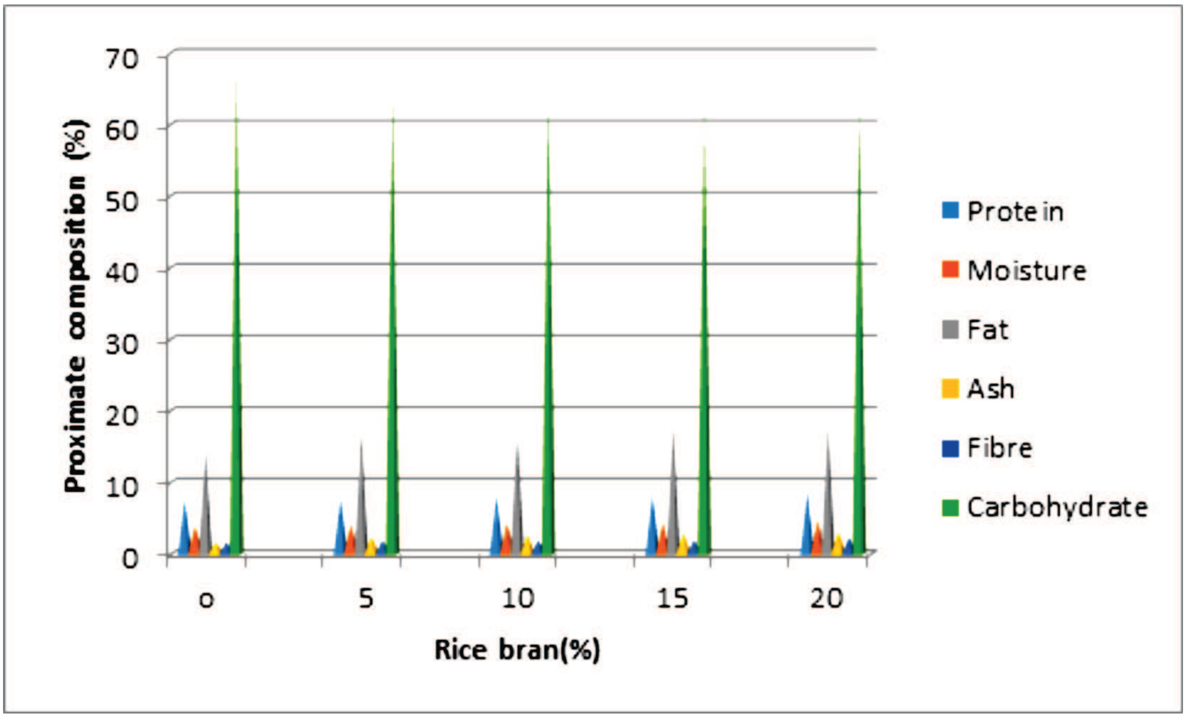

Fig. 1: Chemical Composition of acha-rice bran flour blend biscuits.

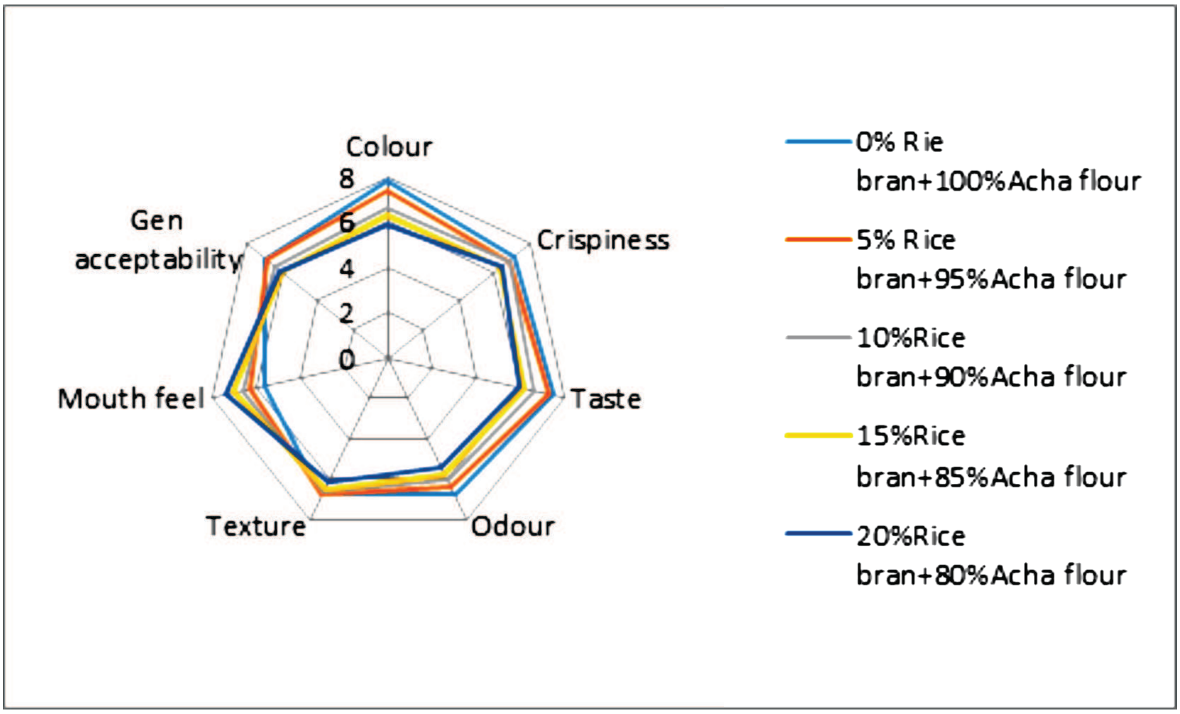

Fig.2: Spider web graph showing the sensory quality of acha-rice bran flour blend biscuits