QUALITY EVALUATION OF ACHA-BASED BISCUITS INCORPORATED WITH DEFATTED MELON SEED COTYLEDON

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Abstract

The chemical, physical and sensory properties of acha-based biscuit incorporated with defatted melon seed flour were studied. Defatted melon seed flour was substituted into acha flour at 5, 10, 15, 20 and 25% to produce acha-defatted melon flour blend with 100% acha and 100% wheat flour as the control. The blended flour with other ingredients (fat 50%, sugar 50%, baking powder 15% and salt 1%) fermented and baked at 180ºC to produce the flour blends biscuitsfor the biscuit.The phytochemical content: flavonoid and carotenoid increased from 0.289 to 0.432 and 0.326 to 0.461mg/100g, respectively, with increase in added defatted melon seed flour. The vitamin A and vitamin B1 content of the acha-defatted melon seed flour blend biscuits increased slightly from 0.051 to 0.066, and decrease from 0.929 to 0.791mg/100g, respectively, with increase in the added defatted melon seed flour. The potassium, iron and magnesium contents of the acha-defatted melon biscuit increased from 372.087 to 455.050, 4.406 to 4.563 and 16.95to 40.5325mg/100g respectively, with increase in added defatted melon seed flour. The average mean scores of odor, color, texture decreased from 7.55-6.15, 6.5-6.15, and 6.35-6.30 respectively, with increase in the added defatted melon seed. The incorporated defatted melon seed cotyledon had a significant effect, p=0.05 on the nutrien compostion and sensory quality of the acha-defatted melon flour blend biscuits. The most acceptable and preferred flour blends biscuits contain 10% defatted melon seed flour.

Keywords: Evaluation,Acha,Melon seed,Biscuits,Defatted

Introduction

Biscuits represent the largest category of snack foods among bakery products because excepted to be made from simple, cheap and easily available raw as observed in developed nations .They are widely consumed because of their acceptable taste and their low water activity allows a long shelf life (Chuahan., et al., 2015). Because biscuits are generally made from wheat flour and fat, they are also high-energy easily digestible foods. This can have adverse effects on health if they are consumed regularly, particularly in excess (Caleja.,et al.2017). Although, biscuits vary in their shapes, sizes and composition, the three main ingredients are always flour, sugar and fat (butter or vegetable shortenings) (Caponio.,et al.2006). Commercial biscuits normally constitute 50% of calories from fat and carbohydrates, with over 400 calories per 100 g in plain biscuits (Protonotariou., et al.2016). Biscuits broadly form into two groups, hard and soft biscuits, depending on their ingredient mix (Sudha.,et al.2007) . Commercial biscuits are prepared from refined wheat flour that consists mainly of carbohydrate as starch (70–75%), water (13-15%), protein (10-12%), fat 1-2%, together with some fiber, ash and minerals(Goesaert., et al. 2005) .

Acha, (*Digitaria exilis stapf*) also known as fonio or acha,is a naturally gluten -free African cereal suitable for use in the diet celiac patients jideani *et al* ,2011.despite its low agronomic yield potential ,acha is gaining importance as a crop and food ingredient due to its superior nutritional characteristic compared with other cereals,the increasing market interest in traditional foods,and and its suitability to be growth in tough conditions,such as the arid soil. Acha has a high content of calcuim and iron,compared to the other cereals indicated in the food composition Barikmo *et al*,2004 .Like most cereals, acha is deficient in essential amino acids such as lysine and tryptophan, therefore enrichment of cereal based foods with other protein source such as legumes has received considerable attention (Mensah *et al.*, 2003).

Egusi-melon (is a member of the Cucurbitaceae family (Schippers, 2000**).** It is a variety of melon seed which is popularly called 'Egusi' in West Africa (Akpambang *et al*., 2008). Other common names include, 'Ibara', wild watermelon **(**Abrefa, 2003) and egusi–melon (Ayodele and Salami, 2006; Idehen *et al.*, 2008; Ojieh *et al.*, 2008). The crop is widely cultivated in Nigeria (Ezeike and Offen, 1989; Jolaoso *et al.*, 1996; Anuebunwa, 2000) and other African countries for its seeds (Ogbonna and Obi, 2007).The seeds provide a well relished condiment for soup. It is rich in oil (53%), protein (28%) (Bankole *et a*l., 2005), vitamins (A, B_1, B_2 and C) and a good source of minerals such as S, K, P, Ca, Mg, Fe and Zn, which are known to eliminate tape worm and to serve as a purifier of internal organs. (An Ku, 2007). It is also an excellent essential amino acid (Schippers, 2000.), polyunsaturated fatty acids, and phospholipids and also contains significant amounts of tocopherols and phenolic compounds which are beneficial to humans (Mariod and Matthaus, 2008).

Acha is low in protein, and therefore, it calls for enrichment/ fortification. Melon seed cotyledon is presently underutilized probably due to unavailability in foods.

Enrichment of acha products with added food like melon will help to improve the nutrient content and will also improve the under utilization of melon

The objective of this study is to determine the quality of acha-based biscuits incorporated with melon seed on the physical, chemical and sensory composition of biscuits.

Materials and Method

Materials

The raw materials used in this work include; melon seed, acha, wheat flour, baking powder, fats (Simas), sugar, salts. These materials were purchased from was purchased from new market Wukari Taraba state, Nigeria.

2.2 Sample Preparation

Production of acha flour

The acha grain was washed (using tap water), de-stoned (manually using sedimentation method), dried (sundried or oven dried at 50 for 3 h); milled (Hammer mill), and sieved (0.4mm sieve aperture) to obtain acha flour, packed hermetically in polythene bags till usage (**Ayo *et al.* 2007)**.

Production of melon seed flour

Th**e** melon seed cotyledon was dehulled to remove the peel, and sorted to remove the discolored ones, washed and dried. It was milled with attrition mill and defatted using ethanol (this is done using the soxhlet apparatus). The defatted melon seed was oven dried (at 70ºc for 4 hours) and milled using attrition mill. And sieved to obtain melon flour and packaged in polyethylene bag until usag

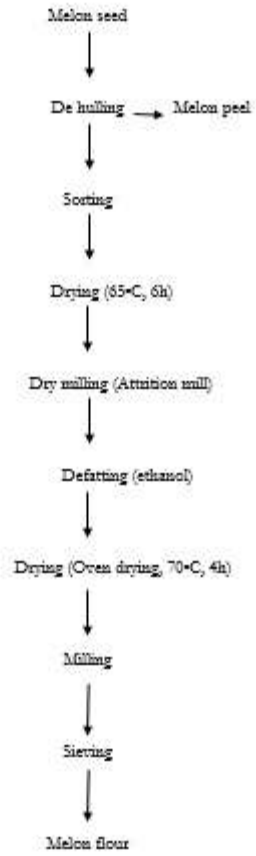

Fig 2: Flow chart for the production of melon flour
Source: Ojo and Enujiugha, (2016)

Production of biscuits

The defated mellon was substituted into acha flour at, 10, 15, 20 and 25% to prpduce defatted mellon-acha flour blends. Fat(50%) was blended into sugar(50%),baking powder (15%) and (salt 1%) blends, was mixed with to form a homogeneous paste The rested paste was rolled out into sheets and cut into shapes, using biscuit cutters. The paste was placed on well greased baking trays and baked for 20 minutes in an oven pre-heated to 220 °C, allowed to cool, and then packaged in high density polyethylene bags air tight container (Chima and Fasuana 2017)

Analytical method

Proximate composition of Acha- defatted melon seed flour blend biscuits

Determination Proximate Composition

The biscuits were analysed for moisture, crude protein, ash, crude fat, and crude fiber c,ontent was carried out (AOAC 2012). The carbohydrate (CHO was determined as 100 - (% moisture +%protein+%fat+% ash).

Vitamins of Acha- defatted melon seed flour blend biscuits

Vitamin B1 (Thiamine) : This was determined using the method described by AOAC (2010). Five grams of each sample was homogenized in 5 mL normal ethanoic sodium hydroxide solution. The homogenate was filtered and made up to 100 mL with the extract solution. A 10 mL aliquot of the extract wasdispensed into a flask and 10 mL potassium dichromate solution was added. The resultant solution will be incubated for 15 min at room temperature (25±1EC). The absorption was read from spectrophotometer at 360 nm using a reagent blank to standardize the instrument at zero.

Vitamin A: Vitamin A was calculated from beta-carotene based on the assumption that 12 µg of beta-carotene converts into 1 µg of retinol activity equivalents (Tang, 2010).

Mineral composition of Acha- defatted melon seed flour blend biscuits

Determination of Phosphorous: Determination of phosphorous was done according to the method of AOAC (2012).

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Determination of Magnesium: The magnesuim content was determined using AOAC(2012).

Determination of iron content : Five (5) ml of sample solution was transferred into 50 ml volumetric flask. Ten (10) ml of ammonium acetate buffer solution and 2 ml phenonthroline solution was added, and then diluted to the mark with distilled water. The reagents will be mixed thoroughly and allowed to stand for 10 minutes for maximum color development. Standard solution was repared by measuring 1 g of pure iron wire into 100 ml concentrated HNO_3, in a water bath and will be diluted to 1000 ml with distilled water. From this stock, standard solutions of 0.0, 0.5, 1.0, 2.0 and 4.0 ppm will be prepared and used for equipment calibration. Total iron was determined using appropriate iron lamp.

Phytochemicals of Acha- defatted melon seed flour blend biscuits

Determination of flavonoids : This will be determined according to the method of Harborne (1980). Five (5) g of the sample was boiled in 50 ml of 2 M HCI solution for 30 minutes under reflux. It was allowed cool and subsequently filtered through a filter paper. A measured volume of the extract will be recovered by filtration using weighed filter paper. The resulting difference was the weight of the flavonoid in the sample.

Determination of carotenoids : This was carried out in accordance with the method described by Onyeka and Nwambekwe (2007). A measured weight of the sample was homogenized in methanol using a laboratory blender. (1:10, sample: methanol). The homogenate will be filtered to obtain the initial crude extract using about 20 ml of distilled water in separating funnel. The other layer will be recovered and evaporated to dryness at low temperature (35-50 ºC) in vacuum desiccator. The dry extract was saponified with 20 ml of ethanoic potassium hydroxide and left overnight in a dark cupboard. After a day, the carotenoid was taken up in 20 ml distilled water. The carotenoid extract (ether layer)

was dried in a desiccator and treated with a light petroleum (Petroleum spart) and allowed to stand overnight in a freezer. The next day, the precipitated steroid was removed by centrifugation and the carotenoid extract evapourated to dryness in a desiccator and weighed. The weight of carotenoid was determined and expressed as percentage of the sample weight.

Physical properties of Acha- defatted melon seed flour blend biscuits

Weight : The weight and diameter of the baked biscuit was determined by weighing on a weighing balance and measuring with a calibrated ruler respectively (Ayo *et al.*, 2007).

Spread ratio : The spread ratio was determined using the method of Gomez *et al*. (1997) three rows of five well-formed biscuit was made and the height measured. Also the same was arranged horizontally edge to edge and sum diameter measured. The spread ratio is calculated as diameter/ height.

Break strength : The break strength of the biscuit will be determined using the method of Okaka and Isieh (1990). Biscuit of known thickness (0.4cm) was placed between two parallel wooden bars (3.0cm aparture Weights will be added on the biscuit until the biscuit snapped. The least weight that caused the breaking of the biscuit will be regarded as the break strength of the biscuit.

Sensory evaluation of Acha- defatted melon seed flour blend biscuits

The sensory characteristics of the biscuits were carried out by 20 untrained panelists, randomly selected from the Department of Food Science and Technology, Federal University Wukari. The samples were evaluated for desirability in color, texture, taste, flavor and overall acceptability using a 9-hedonic scale test. Water was used to neutralize the taste between samples testing.

Statistical Analysis

All the analyses was conducted in duplicates in completely randomized design. The data was subjected to analysis of variance using Statistical Package for Social Science (SPSS) software version 23, 2017. Means was significantly different and separated by the least significant difference (LSD) test. Significance was accepted at $p<0.05$.

Results and Discussion

Proximate composition of acha-defatted melon seed flour blend biscuits

The proximate composition of defatted melon seed cotyledon biscuits is shown in Table 1. The protein and crude fiber content increased from 7.715 to 13.89 and 0.29 to 0.74%, with increasing melon seed cotyledon (0-25%). The (100%acha) and the sample with 25% has the higest (5.98%) and lowest at 3.995 .This is slightly higher than 2.68 to 3.74% moisture content moisture content of wheat-germinated sesame biscuit reported by Olagun and Ifesan (2013). The relatively low moisture content can guarantee extended shelf life.

The protein content increased from 7.715 to 13.89% with increase in melon seed incorporation from (0 to 25%). The increase in the protein content could be due to substitution of acha with melon seed, since melon seed has (23.4%) of protein as reported by (Ojieh *et al.*, 2007). The protein obtained is within the range of 5.99 to 16.76% for malted soyabean-acha biscuit as reported by (Ayo *et al*., 2014). The higher protein content could therefore be of great importance in human nutrition (Mayo *et al*., 2011).

The fat content of the acha-defatted melon seed flour blend biscuits increased from 19.32 to 21.50 % with increase in added defatted melon seed flour. The increase may be due to the relative higher level of fat in the defatted melon. A fat content of 45.7 was reported by (Ojieh*et al.*, 2007).The increase in the fat content could be a good source of energy to human body. Fats and oils provide more than twice the energy as the carbohydrate on a weight-weight basis (Iwe 2000).

The carbohydrate content decreased from 65.240 to 58.108% with increased in added defatted melon seed flour. The decrease may be due to the lower level of carbohydrate in the added defatted melon seed (10.06 %) as reported by (Ojieh *et al.*, 2007). Carbohydrates are macronutrient such as starch, sugar and fiber found in food, provides the body with energy (Ojieh *et al.*, 2007).

The crude fiber content increased from 0.290 to 0.600%, with increase in added defatted melon seed flour. The fiber increase may be due to the relative higher level of fiber in the added defatted melon seed flour.. A fiber content of (12.0%) was reported by (Ojieh *et al.*, 2007). Crude fiber is important in bowel movement, and could reduce constipation.

Table 1: Proximate composition of acha-defatted melon seed flour blend biscuits

Sample	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)	Crude Fiber (%)
100:0	$5.98^{d}\pm0.000$	$19.32^{a}\pm0.20$	$7.715^{a}\pm0.12$	$65.240^{b}\pm0.09$	$1.995^{b}\pm0.08$	$0.290^{c}\pm0.007$
95:5	$4.44^{ab}\pm0.33$	$21.63^{b}\pm0.56$	$9.150^{b}\pm0.00$	$64.620^{b}\pm1.88$	$1.96^{b}\pm0.021$	$0.420^{c}\pm0.000$
90:10	$4.83^{a}\pm0.33$	$21.39^{b}\pm0.35$	$21.05^{b}\pm0.06$	$62.172^{a}\pm1.23$	$1.717^{b}\pm0.02$	$0.44^{b}\pm0.007$
85:15	$5.23^{bc}\pm0.33$	$21.16^{b}\pm0.14$	$11.955^{c}\pm0.12$	$59.725^{a}\pm0.59$	$1.475^{a}\pm0.02$	$0.46^{a}\pm0.014$
80:20	$4.61^{a}\pm0.38$	$21.05^{a}\pm0.16$	$12.922^{b}\pm0.86$	$58.108^{a}\pm0.68$	$4.137^{a}\pm0.22$	$0.60^{b}\pm0.014$
75:25	$3.995^{a}\pm0.43$	$21.50^{b}\pm0.18$	$13.89^{d}\pm0.12$	$58.108^{a}\pm0.68$	$6.799^{a}\pm0.22$	$0.74^{b}\pm0.014$
100:0	$4.775^{a}\pm0.148$	$6.465^{a}\pm0.545$	$13.215^{c}\pm0.38$	$73.91^{a}\pm0.31$	$2.285^{b}\pm0.007$	0.50a±0.000

Values are means +SD of triplicate determinations Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

Table 2: Phytochemical Composition of acha-defatted melon seed flour blend biscuits

Sample	Flavonoid	Carotenoid
100:0	0.289a±0.136	0.326a±0.025
95:5	0.336 [a]±0.068	0.349[a]±0.003
90:10	0.36[a]±0.102	0.374[a]±0.003
85:15	0.384 [a]±0.136	0.399[b]±0.003
80:20	0.408[a]±0.102	0.860[b]±0.005
75:25	0.432 [a]±0.068	0.461[c]±0.008
P-value	0.616	0.002

Data represents mean + SD (n=3)
Means differently superscripted along the vertical column are significantly (P<0.05) different
Legend: USRDA= United States Recommended Dietary Allowanc

Table 3: Vitamin composition of Acha-defatted melon seed flour blend biscuit

Sample	Vitamin A	Vitamin B1
100:0	0.051[a]±0.000	0.929[a]±0.007
95:5	0.055 [b]±0.000	0.891 [a]±0.004
90:10	0.57[b]±0.000	0.852[a]±0.014
85:15	0.059 [c]±0.000	0.814 [b]±0.025
80:20	0.062[c]±0.0005	0.802[b]±0.017
75:25	0.066 [d]±0.001	0.791 [b]±0.009
P-value	0.000	0.002

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05).

Table 4.4: Mineral composition of acha-defatted melon seed flour blend biscuits

Sample	Phosphorus (P) (mg/100g)	Iron (Fe) (mg/100g)	Magnesium (Mg) (mg/100g)
100:0	372.087[b]±3.532	4.406[a]±0.22	16.950[a]±0.000
95:5	358.490[b]±18.050	4.313 [a]±0.265	29.273 [b]±0.003
90:10	332.269[b]±9.221	4.647[a]±0.243	30.380[c]±0.005
85:15	306.049[a]±0.392	4.981 [a]±0.221	31.488[c]±0.000
80:20	380.549[b]±6.082	4.772[a]±0.199	36.010[d]±0.012
75:25	455.050[c]±11.772	4.563 [a]±0.177	40.532[d]±0.024
P-value	0.001	0.306	0.000

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05).

Phytochemical composition of acha-defatted melon seed flour blend biscuits

The phytochemical composition of acha-defatted melon seed cotyledon biscuits is shown in Table 2. The flavonoid and carotenoid increased from 0.289 to 0.432 and 0.326 to 0.461mg/100g, respectively, with increase in added defatted

melon seed flour. Flavonoids are anti-oxidants, lower cholesterol, inhibit tumor formation, and decrease tumor formation and protect against cancer and heart disease (Adebowale *et al.*,2008).Carotenoids have been proven to improve the recovery of night blindness and loss of appetite (Ayo and Gidado, 2017).

Vitamin composition (mg/100g) of acha-defatted melon seed flour blend biscuits

The vitamin A content of the acha-defatted melon seed flour blend biscuits from Table 4.3 increased slightly from 0.051 to 0.066, while the Vitamin B1 decreased from 0.929 to 0.791mg/100g, with increase in the added defatted melon seed flour (0.25%). The effect is significant, p=0.05. The increase in the vitamin A could be due to the relative high content of the same in the incorporated defatted melon seed. While the reduction in the vitamin B1 could also be due to the relative low content of the same in the incorporation. Vitamin A could help in improving vision and functioning of immune system.

Mineral composition of acha-defatted melon seed flour blend biscuits

The mineral composition of acha-defatted melon seed flour blend biscuits is shown in Table 4.4. The potassium, Iron and Magnesium content of the biscuit increased from 372.087 to 455.050, 4.406 to 4.563 and 16.95to 40.5325mg/100g with increase in added incorporated blend. The effect is significant, p= 0.05. Iron is very important in the production of hemoglobin (a protein in red blood cells that carries oxygen from the lungs to all parts of the body) and myoglobin (a protein that provide oxygen to muscles) (Mason, 2016). Phosphrorus also helps the body in the production of ATP, a molecule the body uses to store energy. Phosphorus is important for utilization of B vitamins. It also helps the following: kidney function, muscle contractions, normal heartbeat, nerve signaling.

Physical properties of cha-defatted melon seed flour blend biscuits

The physical property of the acha based biscuit incorporated with defatted melon seed cotyledon is shown in Table .5. The spread ratio of the acha-defatted melon seed flour blend biscuits increased from 4.73 to 5.00 with increase in the added defatted melon seed flour. The reduction in the break strength of the acha-defatted melon seed flour blend biscuits could be due to the dilution of the carbohydrate hence reducing the blend formation in the matrix of the biscuits. The break strength decreased from 913.33 to 553.33g with increase in the added defatted melon seed flour. The increase in the spread ratio could be due to the dilution of the carbohydrate by the added defatted melon seed flour blend.

Table 5: Physical properties of acha-based biscuit incorporated with melon seed cotyledon

Sample	Break Strength (g)	Weight (g)	Diameter (Cm)	Height (Cm)	Spread Ratio
100:0(wheat)	913.33^{f}±23.09	45.067^{a}±0.15	25.6^{b}±0.32	5.10^{a}±0.10	4.73^{a}±0.55
100:0(Acha)	880^{e}±20.00	45.13^{a}±0.15	25.2a±0.20	5.167_{a}±0.15	4.83^{a}±0.15
95:5	810^{e}±10.00	45.00^{a}±0.30	25.97^{bc}±0.15	5.067^{a}±0.115	5.10^{a}±0.10
90:10	713.33^{d}±11.55	45.20^{a}±0.15	26.77^{d}±0.25	5.30^{a}±0.20	5.00^{a}±0.10
85:15	660^{c}±20.00	46.13^{b}±0.32	26.26^{c}±0.25	5.20^{a}±0.10	5.00^{a}±0.10
80:20	620^{b}±20.00	46.7^{c}±0.26	26.26^{c}±0.208	5.10^{a}±0.10	5.10^{a}±0.10
75:25	553.33^{a}±30.53	45.3^{a}±0.10	26.73^{d}±0.25	5.30^{a}±0.20	5.00^{a}±0.10
P-value	0.000	0.000	0.000	0.315	0.445

Values are means ± standard deviation of 3 replicates. Mean within a column with different superscripts were significantly different at (p=0.05)

Sensory properties of Acha-defatted melon seed flour blend biscuits

The sensory quality of the acha-defatted melon seed flour blend biscuits is shown in Table 4.6. The average mean scores of the taste, color, odor, texture, and general acceptability of the acha based biscuit increased from 6.15 to 6.90, 5.20 to 6.45, 5.45 to 6.90, 5.20 to 5.90 and 5.60 to 6.65 respectively, with added defatted melon seed flour. The effect of melon seed incorporation into the flour blend to produce biscuit is significant, p=0.05. The most cceptable and preferred blend biscuit is that of 10% defatted melon seed.

Table 4.6: Sensory evaluation of acha-defatted melon seed flour blend biscuits

Sample	Odor	Taste	Color	Texture	General Acceptability
100:0 Wheat	7.55 ^{a}±1.79	8.00 ^{a}±1.85	6.50 ^{a}±1.85	6.35 ^{a}±2.033	6.95 ^{b}±1.731
100:0 Acha	6.30^{ab}±1.59	6.90^{ab}±1.62	6.00^{a}±1.95	5.65^{a}±1.814	6.25^{ab}±1.682
95:5	6.80 ^{b}±1.47	7.30 ^{ab}±1.455	6.20 ^{a}±1.795	5.60 ^{a}±1.759	6.30 ^{ab}±1.261
90:10	6.90 ^{b}±1.71	6.80 ^{a}±1.473	6.80 ^{a}±1.936	5.40 ^{a}±1.465	6.60 ^{a}±2.062
85:15	6.35 ^{ab}±1.90	6.15 ^{a}±1.785	6.45 ^{a}±1.849	5.35 ^{a}±1.927	5.60 ^{a}±2.210
80:20	5.45 ^{c}±1.76	6.35 ^{b}±1.95	5.50 ^{a}±1.821	5.30 ^{a}±2.093	5.60 ^{a}±1.957
75:25	6.15 ^{ab}±1.76	6.35 ^{a}±2.197	5.15 ^{a}±1.843	5.30 ^{a}±1.804	5.65 ^{a}±1.981
P-Value	0.009	0.024	0.250	0.000	0.001

Values are means ± SD of triplicate determinations.
Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

Conclusion

The addition of defatted melon seed flour to acha flour has shown to have significant effect n the flour blend biscuits. The nutrient compositions were relatively improved. The relatively moisture content of the produced biscuits could be an added value to its shelf stability. The acha based biscuits is generally acceptable with addition of defatted melon seed flour, however it is most preferred at 10% level of the added melon seed flour.

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