International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.04, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Characteristics of wheat cookies supplemented with Chenopodium (*Chenopodium album*) flour: Physico-chemical, in-vitro antioxidant, textural and sensory properties

Romee Jan[1*], D. C. Saxena[2] and Sukhcharn Singh[3]

[1] *Department of Proccessing & Food Engineering,*
Punjab Agricultural University, Ludhiana, Punjab 141004, India.
[2] *Sant Longowal Institute of Engineering & Technology,*
Longowal, District Sangrur, Punjab 148106, India.
[3] *Department of Food Engineering & Technology, Sant Longowal Institute of Engineering & Technology, Longowal Deemed University (MHRD, New Delhi), Sangrur, Punjab 148106, India.*

ABSTRACT

Cookies were prepared by supplementing Chenopodium album flour into wheat flour at various levels (10%, 20%, 30%, 40% and 50%). Physicochemical, antioxidant and color characteristics of C. album-wheat blend flour were studied while the cookies developed were analyzed for their physical, textural, color and sensory properties. Peak and final viscosity of wheat flour decreased significantly ($p<0.05$) from 1873 to 530 cP and 2580 to 1074 cP, as the level of C. album flour increased while significant increase in pasting temperature values were found from 69.30 to 89.65°C, respectively. Similarly, a significant improvement in functional and in-vitro antioxidant characteristics (antioxidant activity, total phenolic content, and total flavonoid content) was observed as the proportion of C. album flour increased. Significant ($p<0.05$) decrease was observed in spread ratio (7.33 to 4.84) and peak snap force (52.50 to 27.56 N) of cookies. Increasing levels of C. album flour lead to a significant decrease in L values (60.10 to 34.40) of cookies. The overall acceptability score of 7.25 for cookies (50% wheat flour and 40% C. album flour) suggests their consumer acceptability. The present study showed substantial nutritive and functional improvement by the addition of C. album flour to cookie formulation.*

***Keywords**: C. album, cookies, pasting properties, texture, sensory analysis*.

1. INTRODUCTION

The pseudo cereals have gained more importance in current years due to their excellent nutritional value. These pseudo cereals provide good quality protein, dietary fibre and lipids rich in unsaturated fats besides starch, one of the important energy sources [1]. Pseudo cereals have enormous quantity of important micronutrients such as minerals and vitamins and significant amounts of other bioactive compounds like saponins, phytosterols, squalene, fagopyritols and polyphenols [2]. In addition, pseudo cereals seeds are also gluten-free and thus are currently emerging as healthy alternatives to gluten-containing grains in the gluten-free diet [3]. Baking, the thermal processing of cereals can also result in the synthesis of substances such as some Maillard reaction products having antioxidant properties [4]. In a previous study [1], the use of pseudo cereals as potential healthy ingredients for improving the nutrient content of cookies was evaluated wherein results showed that the pseudo cereals may represent feasible ingredients for the development of nutrient-rich gluten-free products. So the nutritional benefits of these pseudo cereals were highlighted both for celiac patients as well as for the general population.

Chenopodium album is an annual underutilized pseudo cereal of the *Chenopodium* genus. *Chenopodium* spp. has been cultivated as leafy vegetables and as a subsidiary grain crop in different parts of the world for centuries. The standard British name is Fat-hen and is well-known as lamb's quarters. The nutrient composition of Himalayan grain chenopod is much better than wheat, barley, maize and rice. The grain is used as a staple food, consumed in the form of porridge, pudding, and also cooked with rice. The protein quality of grain equals to that of milk and it contains high lysine, methionine and cysteine (6 g /100 g protein, 2.3 g /100 g protein &1.2 g /100 g protein), respectively. Therefore, the nutritional composition of the grain, such as total protein content, amino acid spectrum, vitamin and mineral composition have been found to be comparable or even better than that of common cereal grains and hence the grain because of its high nutritional qualities may possess various baking applications.

The bakery industry is one of the largest organized food industries all over the world particularly in biscuits and cookies, which are one of the most popular products because of their convenience, ready to eat nature**,** and long shelf life. Cookies are popular and widely consumed snacks all over the world for people of all ages. The major ingredients in cookies comprise flour, sugar, and fat content. A variety of minor ingredients are also been recommended which improve the physical characteristics and eating qualities [5]. A deficit of fibre intake in the diet of an average consumer raised the issue of the development and production of dietary fibre-enriched cookies as the point of interest for both producers and researchers [6]. Composite flour bakery products possess lots of advantages, besides extending the availability of wheat flour, and they act as carriers of nutrition [7]. Thus the nutritional composition of bakery products can be improved by supplementing flour with protein rich non-wheat flours [8], which will promote the utilization of non-wheat cereals and their by-products by the larger segment of population. Therefore the objective of present study was to examine the effect of *C. album* flour on the quality, physical and sensory characteristics of *C. album*- wheat flour blend cookies formulations.

2. MATERIAL AND METHODS

2.1 Material

The grains of *C. album* are not commonly available in market. Hence, the grains of *C. album* var. local Punjab (V1) was locally procured. Grains were cleaned, stone milled and passed through 44 mesh sieve (355µm) to obtain a uniform size of flour and stored at 4°C in refrigeration conditions till further analysis and stored in air tight container in refrigeration conditions at 4°C till further used. The other ingredients like wheat flour, sugar, shortening, skim milk powder and salt were purchased from local market Sangrur, (India).

2.2 Proximate composition

Moisture, ash and fat content of flour were determined according to Association of Official Analytical Chemists AOAC, [9] methods. The crude fiber content was determined using the AACC, [10] methods. Carbohydrate content was calculated by difference [11]

2.3 Functional properties

Bulk density (packed and loose) of blend flours was measured by method of Okezie and Bello [12] with slight modifications. A weighed sample (10 g) was put in a 25 ml measuring cylinder and the volume was recorded as the loose volume. The cylinder was then tapped repeatedly on a rubber sheet until a constant volume was observed. The packed volume was recorded. The loose bulk density (LBD) and packed bulk densities (PBD) were calculated as the ratio of the sample weight to the volume occupied by the sample before and after tapping. Water absorption capacity and water solubility index of wheat and blend flours were determined as per the method of Sharma and Gujral [13]. The oil absorption capacity was determined according to method of Lin et al. [14].

2.4 Pasting properties

Pasting properties of blend flours were determined by Rapid Visco Analyzer (RVA Tecmaster, Perten, Australia) using the Standard profile 1. Flour sample (3 g) was mixed with 25 ml of distilled water to make a total of 28 g of flour suspension in the RVA sample canister. The flour suspension was held at 50°C for 1 min and then heated to 95°C for 3 min and after that the suspension was held at 95°C for 3 min before it was subsequently cooled to 50°C for 4 min and then held at this temperature for 2 min. RVA parameters i.e. peak viscosity, trough viscosity, final viscosity, breakdown, set back, and pasting temperature were recorded. All the measurements were repeated thrice.

2.5 Antioxidant activity (DPPH radical scavenging activity)

Antioxidant activity (AOA) was determined by the method of Huang et al. [15] with slight modifications. To 0.1 ml of the extract solution, 3.9 ml of DPPH solution was added and mixed followed by an incubation period of 30 min in dark at room temperature. The absorbance of the resultant mixture was taken at 515 nm and scavenging effect of DPPH radical was calculated by the following “equation 1”:

$$DPPH radical scavenging activity\ (\%) = \left\{\left[\frac{blank - absorbance}{blank}\right]\right\} \times 100 \qquad (1)$$

2.6 Total phenolic content

Total phenolic content was analyzed using by the Folin–Ciocalteu assay as mentioned by Singleton and Rossi [16] with some modifications. The prepared extract (0.05 ml) was mixed with 0.55 ml distilled water and 0.25-ml of 20% Folin–Ciocalteu reagent. 0.5-ml of 0.5 M ethanolamine was added to the mixture after a period of 5 min and the resulting mixture was kept for 90 min at room temperature. The absorbance of the mixture was measured at 760 nm against the reagent blank and expressed in units of mg GAE/g.

2.7 Total flavonoid content

The TFC were calculated as per the procedure of Zhishen et al. [17] with slight modification. The extract solution (0.25 ml) was mixed with 1-ml distilled water and 0.075ml of 5% sodium nitrite (w/v). After 5 min, 0.15-ml of 10% $AlCl_3$ (w/v) was added to the mixture. The mixture was diluted with 0.5-ml 1 M NaOH after a period of 6 min, with subsequent addition of 0.5-ml distilled water. The resulting mixture was centrifuged at 5000g for 10 min at room temperature and the absorbance was determined at 510 nm against the reagent blank. The results of TFC were expressed as mg RUE/g.

2.8 Cookie formulation and preparation

Five formulations of cookies were prepared with slight modification to standard method of AACC (10-50D) [18] from *C. album* and wheat flour viz. F1 (10:90), F2 (20:80), F3 (30:70), F4 (40:60) and F5 (50:50), respectively using the following ingredients. Flour (100 g), sodium bicarbonate (2.0 g), salt (1.5 g), skim milk powder (10 g) shortening (50 g) sugar (45 g) and water (18 ml). Shortening and sugar were mixed to a cream, then the mixture of flour, sodium bicarbonate and skim milk powder were added and mixed thoroughly to form dough. The dough was kneaded, sheeted to a uniform thickness of 0.5 cm and then cut into circular shapes of 5 cm diameter. Baking was carried out at 175 $^{\circ}$C for 10 min. Cookies prepared were cooled and stored in air tight containers. Results of the data obtained of cookie formulations were compared with the control wheat flour cookies.

2.8.1 Physical analysis of cookies

Diameter and thickness were measured in each cookie with a vernier calliper at two different places and the average was calculated (for each cookie one value was considered). The average of 6 cookies for each batch was recorded, whereas weight of cookies was determined with an electronic weighing balance. The spread ratio was calculated by using the formula: diameter divided by height of cookies [19].

2.8.2 Texture analysis of cookies

Texture analyzer (TA-XT2i, Stable Micro Systems, UK) was used to measure the hardness of the baked cookies in a compression mode with a sharp-blade cutting probe. The Pre-test, test, and post-test speeds were 1.5, 2, and 10 mm/s, respectively. Hardness defined as a maximum peak force, was measured with more than six cookies per sample and reported as fracture force in N. Results are measurements of six experiments and expressed as mean ± SD values.

2.8.3 Color measurement of cookies

Surface color measurement on the basis of CIE L*, a*, b* color system was carried out by using a Hunter Colorimeter fitted with optical sensor (Hunter Associates Laboratory Inc., Reston, VA, USA). Results are measurements of six experiments and expressed as mean ± SD values.

2.8.4 Sensory evaluation

Cookies made from wheat and *C. album* flours blends were evaluated for color & appearance, aroma, taste, texture, mouth feel & overall acceptability by thirty (30) semi-trained panelists drawn within the university community. The cookie samples were rated by using a 9-point hedonic scale (9-like extremely to 1-dislike extremely).

2.9 Statistical analysis

Data were analyzed by Duncan's multiple range test [20] using statistical 7 (statistical _soft, TULSA, USA) and the means which are significantly different were determined by statistical software packages at $p<0.05$. All the tests were carried out in triplicates.

3. RESULTS AND DISCUSSION

3.1 Proximate composition

The chemical compositional analysis of flour is shown in Table 1. There was no significant difference (*p<0.05*) found in moisture content between *C. album* and wheat flour. However, the *C. album* flour showed significantly higher protein, ash, fat and fiber content than wheat flour in the percentage of 13.12, 3.25, 6.50 and 13.09 g/100g, respectively. While the carbohydrate content was found higher in wheat flour (76.81 g/100g) than *C. album* (54.61g/100g).

3.2 Functional properties

The functional properties of wheat flour and blends are presented in Table 2. Both the packed and loose bulk density of wheat flour decreased from 0.76 to 0.71 g/ml and 0.52 to 0.41 g/ml following the addition of *C. album* four. The higher the bulk density, the denser the flour and vice-versa. Bulk density is very important in determining the packaging requirement, material handling and application in wet processing in the food industry [21]. The higher bulk density is desirable for greater ease of dispensability of flours. In contrast, however, low bulk density would be an advantage in the formulation of complementary/weaning foods for infants [22]. The water absorption and water solubility index of wheat flour increased marginally upon incorporation of *C. album* flour (Table 2).This variation in water absorption may be attributed to increased levels of protein and fiber in the blend flours. The results are in agreement with the Kiin-Kabari et al. [23] and Adebowale et al. [24] who earlier reported that the ability of food materials to absorb water is sometimes attributed to the protein content. Water absorption capacity is important in bulking and consistency of product as well as in baking applications [25]. Similarly oil absorption capacity of the blends increased significantly upto 30% incorporation however with further substitution it increased marginally. This may be attributed to the higher oil holding capacity of fiber and non-polar hydrophobic components of proteins. Eltayeb et al. [26] postulated that non-polar amino acid side chains form hydrophobic interactions with hydrocarbon chains of lipid and thus implicates the functional properties of flours. Oil absorption index is of importance since oil acts as flavor retainer and increase the mouth feel of foods, improvement of palatability and extension of shelf life particularly in bakery or meat products where fat absorptions are desired [27].

3.3 Pasting properties

Results of the pasting properties are shown in Table 3 and displayed in Figure 1. The pasting characteristics are important in predicting the pasting behavior and ability of the flour samples. They affect texture and digestibility as well as the end use of starchy foods and hence may influence quality and aesthetic considerations in the food industry [28]. It was observed that with increase in proportion of *C. album* flour the viscosity of wheat flour decreased progressively. Peak viscosity was found to range from 1873 to 530 cP showing the highest value for 100% wheat flour and lowest value for F5 (50% wheat flour substituted with 50% *C. album* flour). The decrease in peak viscosity may be attributed to high fiber content of *C. album* flour and differences in protein content which suggests that the interaction of present components like fats and protein of *C. album* flour with wheat starch lowers the peak viscosity of the blends [29, 30]. Breakdown value and final viscosity decreased from 661 to 114 cP and 2580 to 1074 cP, respectively. Adebowale et al. [28] reported that the higher breakdown value indicates the lower ability of the sample to resist heating and shear stress during cooking and vice versa. The final viscosity is used to determine the quality of a particular starch based sample. Shimels et al. [31] reported that final viscosity indicates the starch aptness to form a numerous paste or gel after cooling and that less stability of starch paste is accompanied commonly with high value of breakdown. The pasting temperature of wheat flour increased from 69.30°C to 89.65°C with incorporation of *C. album* flour to wheat flour blends. Pasting temperature gives an indication of the first detectable increase in viscosity and the paste formation. A higher pasting temperature implies higher gelatinization, higher water binding capacity and lower swelling property of starch owing to a high degree of association between starch granules [32]. The increase in pasting temperature values may be due to the buffering effect of *C. album* flour lipid on starch which restricts the gelatinization process and the dough rheological behavior depend on its flour composition [30].

3.4 Antioxidant activity (AOA), total phenolic and total flavonoid content

The antioxidant activity of blend flours significantly ($p<0.05$) increased from 4.83 to 9.87% on increasing the level of *C. album* flour in the wheat flour (Table 4). This may be due to the higher antioxidant activity of *C. album* flour in comparison to wheat. Similarly the TPC and TFC increased significantly ($p<0.05$) from 15.70 to 83.40 mg/100g and 1.99 to 3.10 mg/g as the proportion of *C. album* flour in the blends increased (Table 4). Holtekjolen et al. [33] reported significant increase in total phenolic content upon replacement of wheat flour with barley flour. Phenolic compounds are most important contributors to the antioxidant capacity of cereal grains, and play an essential role in the prevention and control of degenerative diseases [34].

3.5 Physical analysis of cookies

Data for physical properties of cookies are summarized in Table 4. Spread ratio or diameter of cookies has long been used to ascertain the quality of flour for developing cookies [35]. Earlier, Olapade and Adeyemo, [36] reported that the lowest spread ratio implies better rising ability of cookies. Physical analysis of cookies revealed higher spread ratio for wheat flour cookies (7.33), which decreased significantly ($p<0.05$) to lower level (4.84) with the addition of *C. album* flour. Similar results were found by Sharma and Gujral, [37] in barley blend cookies. Kaur et al. [38, Yadav et al. [39] reported decreased spread ratio of wheat flour cookies substituted with fenugreek and buckwheat flour. This decrease in spread ratios of cookies may be attributed to the higher protein content and increased level of fiber in *C. album* flour with increased numbers of hydrophilic sites which form aggregates and compete for the limited free water in cookie dough. These hydrophilic sites cause rapid partitioning of free water which leads to higher sugar concentrations in the water phase resulting in higher internal dough viscosity and thus, limited cookie spread [40]. It was observed that the weight of cookies increased from 11.93 to13.58 g with addition of *C. album* flour to wheat flour. This increase in weight of cookies might be due to higher protein and fiber content of *C. album* flour which resulted in higher absorption of moisture. Bake loss was calculated for each cookie as the difference between weights of cookie after baking and cookie dough before baking. Bake loss of cookies was decreased as the incorporation of *C. album* flour increased in the blends due to high water holding capacity, which may be owed to the high-protein content or soluble and insoluble fibers present in *C. album* flour [41]. Weight loss could be used as an indicator of the amount of water evaporated and porous structure developed during baking [42].

The hardness as the peak force required to break the cookies decreased significantly ($p<0.05$) with incorporation of *C. album* flour (Table 4). The hardness of cookies was noticed to decrease from 52.50 to 27.56N, respectively as the level of *C. album* flour increased. Similar trend of results have been found in sorghum-wheat blends and oat-wheat blends cookies [43]. Hoseney and Rogers, [44] reported that hardness of the cookies originates from the interaction of proteins and starch by hydrogen bonding. So the strong interaction of protein (gluten) and starch in control cookie (wheat) might have contributed to higher hardness. However due to absence of gluten protein in *C. album* flour the hardness of cookies was found to decrease with subsequent supplementation of this flour to wheat flour.

3.6 Color characteristics of flour and cookies

The color values of composite flour and cookies are depicted in Table 6. The lightness L* and b* values was decreased significantly ($p<0.05$) from (62.40 to 42.20) and (24.20 to 16.11) for blend flours and from (60.10 to 34.4) and (28.03 to 24.88) for cookies as the addition of *C. album* flour increased in the blends. The a*value was increased from (5.80 to 8.20) for blend flours while it varied from (6.33 to 8.64) for cookies upon inclusion of *C. album* flour. The decrease in lightness/yellowness of flour as well as cookies may be owed to dark color of *C. album* flour and subsequently to browning reaction which occurs during baking process. Maillard browning and caramelization of sugar is considered to produce brown pigments during baking and hence results in the darkening of the product [45]. These browning reactions are influenced by many factors such as water activity, sugars, temperature, pH, and type/ratio of amino compounds [46].

3.7 Sensory analysis

The data about sensory evaluation of cookies are narrated in (Table 7). The cookies prepared were evaluated for their color & appearance, aroma, taste, mouth feel, texture and overall acceptability. The results revealed that sensory scores of cookies for color & appearance, aroma, taste, mouth feel, and overall acceptability decreased. However, the cookie texture was improved significantly with incorporation of *C. album* flour. Cookies prepared from *C. album* flour were darker in color due to presence of higher phenolic compounds and hence showed lower scores for color as compared to wheat flour cookies. From the results, it was found that the addition of *C. album* flour to wheat flour resulted in appreciable consumer scores. Although the cookies prepared from formulation (F4) was more acceptable than other formulations.

4. CONCLUSIONS

Whole *Chenopodium album* flour as a good source of protein with complete amino acid profile seems to be suitable for the preparation of cookies. Addition of *C. album* flour has significantly affected the pasting, functional and bioactive/antioxidant characteristics of wheat flour. The studies on composite *C. album* wheat flour cookies have indicated that incorporation of *C. album* flour improved the quality of cookies even at 10-30% replacement of wheat flour. The physical properties of the C. *album* flour enriched cookies were affected in a positive way by demonstrating a lesser hardness (softer eating properties), enhanced functional potential which are desirable in cookies and was extremely liked by panelists. Thus, the study has shown a potential use of *C. album* flour in the preparation of cookies as a partial replacer for wheat. It may be effective for technological and nutritional advantages of cookies which have additional health benefits including enhanced nutrients, and functional effect.

5. REFERENCES

1. L. Alvarez-Jubete, E. K. Arendt, and E. Gallagher. Nutritive value and chemical composition of pseudocereals as gluten-free ingredients. International Journal of Food Sciences and Nutrition, 60, 2009, 240-257.

2. H.H. Wijngaard, and E.K. Arendt. Buckwheat. Cereal Chemistry, 83, 2006, 391-401.

3. C. Kupper. Dietary guidelines and implementation for celiac disease. Gastroenterology, 128, 2005, S121-S127

4. M. Lindenmeier, and T Hofmann. Influence of baking conditions and precursor supplementation on the amounts of the antioxidant pronyl-L-lysine in bakery products. Journal of Agricultural and Food Chemistry, 52, 2004, 350-354

5. B. Pareyt, and J.A. Delcour. The role of wheat flour constituents, sugar, and fat in low moisture cereal based products: a review on sugar-snap cookies. Critical Reviews in Food Science and Nutrition, 48, 2008, 824-839.

6. J.V. Popov-Raljić, J.S. Mastilović, J.G. Laličić-Petronijević, Ž.S. Kevrešan, and M.A. Demin. Sensory and colour properties of dietary cookies with different fiber sources during180 days of storage. Hemijska industrija, 67, 2013, 123-134.

7. R. Bressani. The proteins of grain amaranth. Food Rev Int 1989; 5: 13-38. DOI: 10.1080/87559128909540843.

8. Chavan JK, Kadam SS. Nutritional enrichment of bakery products by supplementation with nonwheat flours. Critical Reviews in Food Science and Nutrition, 33, 1993, 189-226.

9. AOAC. *Official methods of analysis* (15th ed.). Washington, D. C., USA: Association of Official Analytical Chemists. New York, USA, 1995.

10. AACC. 11th edn. St. Paul: The American Association of Cereal Chemists, 2000.

11. R. Jan, D.C, Saxena, and S. Singh. Physico-chemical, textural, sensory and antioxidant characteristics of gluten–Free cookies made from raw and germinated Chenopodium (Chenopodium album) flour. LWT-Food Science and Technology, 71, 2016, 281-287.

12. B.O. Okezie, and A.B. Bello. Physicochemical and functional properties of winged bean flour and isolate compared with soy isolate. Journal of Food Science, 53, 1988, 450-454.

13. P. Sharma, and H.S. Gujral. Milling behavior of hulled barley and its thermal and pasting properties. Journal of Food Engineering, 97, 2010, 329-334.

14. M.J.Y. Lin, E.S. Humbert, and F.W. Sosulski. Certain functional properties of sunflower meal products. Journal of Food Science, 39, 1974, 368-370.

15. D. Huang, B. Ou, and R.L. Prior. The chemistry behind antioxidant capacity assays. Journal of Agricultural and Food Chemistry, 53, 2005, 1841-1856.

16. V.L. Singleton, and J.A. Rossi. Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16, 1965, 144-1581965.

17. J. Zhishen, T. Mengcheng, and W. Jianming. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chemistry, 64, 1999, 555-559.

18. AACC International. Methods 10-50D and 10-52D. *Approved methods of the American Association of Cereal Chemists,* 10th ed. AACC International. St. Paul, MN, U.S.A, 2000.

19. E.I. Zoulias, S. Piknis, and V. Oreopoulou. Effect of sugar replacement by polyols and acesulfane-K on properties of low fat cookies. Journal of the Science of Food and Agriculture, 80, 2000, 2049-2056.

20. D.B. Duncan. Multiple range and multiple F tests. Biometrics 11, 1955, 1-42.

21. S.B. Yellavila, J.K. Agbenorhevi, J.Y. Asibuo, and G.O. Sampson. Proximate composition, minerals content and functional properties of five Lima bean accessions. Journal of Food Security, 3, 2015, 69-74.

22. S. Kavitha, and R. Parimalavalli. Development and evaluation of extruded weaning foods. European Academic Research, 4, 2014, 5197-5210.

23. D.B. Kiin-Kabari, J. Eke-Ejiofor, and S.Y. Giami. Functional and pasting properties of wheat/plantain flours enriched with bambara groundnut protein concentrate. International Journal of Food Science and Nutrition Engineering, 5, 2015, 75-81

24. Y. A. Adebowale, I.A. Adeyemi, and A.A. Oshodi. Functional and physicochemical properties of flour of six mucuna species. African Journal of Biotechnology, 4, 2008, 1461-1468.

25. E. Julianti, H. Rusmarilin, and E. Yusraini. Functional and rheological properties of composite flour from sweet potato, maize, soybean and xanthan gum. Journal of the Saudi Society of Agricultural Sciences, 2015. DOI: org/10.1016/j.jssas.2015.05.005.

26. M. Eltayeb, A.O. Ali, A.A. Abou-Arab, and F.M. Abu Salem. Chemical composition and functional properties of flour and protein isolate extracted from Bambara groundnut (*Vigna subterranean*). African Journal of Food Science, 5, 2011, 82-90.

27. M.O. Aremu, O. Olaofe, and E.T. Akintayo. Functional properties of some Nigerian varieties of legume seed flours and flour concentration effect on foaming and gelation properties. Journal of Food Technology, 5, 2007, 109–115.

28. A.A. Adebowale, L.O. Sanni, and S.O. Awonorin. Effect of texture modifiers on the physicochemical and sensory properties of dried fufu. Food Science Technology International, 11, 2005, 373-382.

29. E. Nuwamanya, Y. Baguma, and P. Rubaihayo. Physicochemical and functional characteristics of cassava starch in Ugandan varieties and their progenies. Journal of Plant Breeding and Crop Science, 2, 2010, 001-011.

30. M. Egouletey, and O.C. Aworh. Production and Physioco-chemical properties of tempe-fortified maize based weaning food. Nigerian Food Journal, 70, 1991, 92-102

31. E.A. Shimelis, M. Meaza and S.K. Rakshit. Physico-chemical properties, pasting behavior and functional characteristics of flours and starches from improved bean (*Phaseolus vulgaris L.*) varieties grown in East Africa. Agricultural Engineering International: CIGR Journal, 8, 2006, 1-18.

32. F. A. Numfor, W.M. Walter, S.J. Schwartz. Effect of emulsifiers on the physical properties of native and fermented cassava starches. Journal of Agricultural and Food Chemistry, 44, 1996, 2595-2599.

33. A.K. Holtekjolen, A.B. Baevere, M. Rodbotten, H. Berg, S.H. Knutsen. Antioxidant properties and sensory profiles of breads containing barley flour. Food Chemistry, 110, 2008, 414-421.

34. H. Zielinski, H. Kozlowska, and B. Lewczuk. Bioactive compounds in the cereal grains before and after hydrothermal processing. Innovative Food Science and Emerging Technologies, 2, 2001, 159-169.

35. A. Bala, K. Gul, and C.S. Riar. Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. Cogent Food and Agriculture, 1, 2005, 1019815. DOI: 10.1080/23311932.2015.1019815

36. A.A. Olapade, and M.A. Adeyemo. Evaluation of cookies produced from blends of wheat, cassava and cowpea flours. International Journal Food Studies, 3, 2014, 175–185.

37. P. Sharma, and H.S. Gujral. Cookie making behavior of wheat–barley flour blends and effects on antioxidant properties. LWT-Food Science and Technology 55, 2014, 301-307.

38. M. Kaur, K.S. Sandhu, A. Arora, and A. Sharma. Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: physicochemical and sensory properties. LWT-Food Science and Technology 62, 2015, 628-632.

39. B.S. Yadav, B.Y. Ritika, and L.Y. Roshan. Studies on functional properties and incorporation of buckwheat flour for biscuit making. International Food Research Journal, 17, 2010, 1067–1076.

40. F. Zucco, Y. Borsuk, and S.D. Arntfield. Physical and nutritional evaluation of wheat cookies supplemented with pulse flours of different particle sizes. LWT-Food Science and Technology, 44, 2011, 2070-2076.

41. C.M. Ajila, K. Leelavathi, and U.J.S Prasada-Rao. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. Journal of Cereal Science, 48, 2008, 319-326.

42. S. Chevallier, G. Della Valle, P. Colonna, B. Broyart, and G. Trystram. Structural and chemical modifications of short dough during baking. Journal of Cereal Science, 35, 2002, 1-10.

43. J.K. Chavan, S.S. Kadam, and N.R. Reddy. Nutritional enrichment of bakery products by supplementation with nonwheat flours. Critical Reviews in Food Science and Nutrition, 33, 1993, 189-226.

44. R.C. Hoseney, and D.E. Rogers. Mechanism of sugar functionality in cookies. The science of cookie and cracker production. American Association of Cereal Chemistry, 1, 1994, 203–225.

45. L. Laguna, A. Salvador, T. Sanz, S.M. Fiszman. Performance of a resistant starch rich ingredient in the baking and eating quality of short-dough biscuits. LWT-Food Science and Technology, 44, 2011, 737-746.

46. P. Sharma, and H.S. Gujral. Extrusion of hulled barley affecting b-glucan and properties of extrudates. Food Bioprocess Technology, 6, 2013, 1374-1389.

IJARSE
ISSN: 2319-8354

LIST OF TABLES

Table 1. Proximate composition analysis of flour

Constituents (%)	Values	
Samples	*C. album*	Wheat
Moisture	$9.43^{a}\pm0.15$	$9.88^{a}\pm0.11$
Ash	$3.25^{a}\pm0.05$	$0.96^{b}\pm0.03$
Protein	$13.12^{a}\pm0.29$	$9.73^{b}\pm0.15$
Fat	$6.50^{a}\pm0.13$	$1.35^{b}\pm0.07$
Crude fiber	$13.09^{a}\pm0.46$	$1.27^{b}\pm0.01$
Carbohydrates	$54.61^{b}\pm1.90$	$76.81^{a}\pm2.40$

Means with different superscript in the same rows are significantly different at $p < 0.05$. Valuesare means ± standard deviation of triplicates

Table 2. Functional properties and color characteristics of wheat-*C. album* blend flour.

Samples	BD (packed)	BD (loose)	WAI (g/g)	WSI (%)	OAC (g/g)	Color		
						L*	a*	b*
Control (100g WF)	$0.76^{a}\pm0.02$	$0.52^{a}\pm8.23$	$1.78^{c}\pm0.20$	$4.00^{f}\pm0.12$	$2.13^{c}\pm0.05$	$62.40^{a}\pm0.90$	$5.80^{f}\pm0.09$	$24.20^{a}\pm0.50$
(F1)	$0.75^{a}\pm0.47$	$0.46^{b}\pm0.75$	$1.82^{c}\pm0.48$	$4.84^{e}\pm0.04$	$2.18^{b}\pm0.66$	$55.60^{b}\pm0.50$	$5.95^{e}\pm0.06$	$23.20^{b}\pm0.16$
(F2)	$0.74^{a}\pm0.06$	$0.45^{b}\pm0.82$	$1.93^{b}\pm0.30$	$5.67^{d}\pm0.08$	$2.19^{b}\pm0.32$	$53.20^{c}\pm0.30$	$6.60^{d}\pm0.10$	$21.45^{c}\pm0.20$
(F3)	$0.73^{a}\pm0.96$	$0.44^{b}\pm0.58$	$1.99^{a}\pm0.14$	$6.31^{c}\pm0.59$	$2.25^{a}\pm0.83$	$46.80^{d}\pm0.44$	$7.10^{c}\pm0.06$	$19.81^{d}\pm0.30$
(F4)	$0.72^{a}\pm0.67$	$0.42^{b}\pm0.21$	$2.00^{a}\pm0.60$	$6.75^{b}\pm0.09$	$2.25^{a}\pm0.04$	$43.95^{e}\pm0.20$	$7.87^{b}\pm0.10$	$17.67^{e}\pm0.14$
(F5)	$0.71^{a}\pm0.34$	$0.41^{b}\pm0.39$	$2.04^{a}\pm0.45$	$6.97^{a}\pm0.80$	$2.35^{a}\pm0.05$	$42.20^{f}\pm0.40$	$8.20^{a}\pm0.12$	$16.11^{f}\pm0.09$

WF, wheat flour ; PV, Peak viscosity; TV, Trough viscosity; BV, Breakdown viscosity; SV, Setback viscosity; FV, Final viscosity; P Temp, Pasting temperature; P Time, Peak time. F1 (90% wheat flour and 10% *C. album* flour); F2 (80% wheat flour and 20% *C. album* flour); F3 (70% wheat flour and 30% *C. album* flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% *C. album* flour). BD, bulk density; TD, true density; WAI, water absorption capacity; WSI, water solubility index; OAC, oil binding capacity. Means with different superscript in the same column are significantly different at $p<0.05$. Valuesare means ± standard deviation of triplicates

Table 3. Pasting properties of wheat-*C.album* blend flour.

Samples	Pasting parameters						
	PV (cP)	TV (cP)	BD (cP)	SV (cP)	FV (cP)	P Temp (˚C)	P Time (min)
Control (100g WF)	$1873^{a}\pm8.02$	$1212^{a}\pm8.23$	$661^{a}\pm3.90$	$1368^{b}\pm5.2$	$2580^{ab}\pm5.12$	$69.30^{b}\pm1.0$	$6.00^{a}\pm5.05$
(F1)	$1631^{b}\pm9.47$	$1078^{b}\pm7.75$	$553^{b}\pm4.89$	$1778^{a}\pm5.48$	$2856^{a}\pm6.04$	$87.15^{a}\pm4.99$	$5.53^{a}\pm6.66$
(F2)	$1490^{b}\pm8.06$	$1016^{b}\pm6.82$	$474^{c}\pm2.78$	$1922^{a}\pm9.30$	$2938^{a}\pm4.08$	$87.95^{a}\pm3.72$	$5.60^{a}\pm7.32$
(F3)	$1073^{c}\pm3.96$	$738^{c}\pm3.58$	$335^{d}\pm3.46$	$1422^{b}\pm7.14$	$2160^{bc}\pm6.59$	$88.75^{a}\pm3.54$	$5.33^{a}\pm6.83$
(F4)	$821^{c}\pm5.67$	$593^{d}\pm2.21$	$228^{e}\pm2.08$	$1013^{c}\pm4.60$	$1606^{cd}\pm4.09$	$89.55^{a}\pm4.87$	$5.40^{a}\pm6.04$
(F5)	$530^{d}\pm4.34$	$416^{e}\pm3.39$	$114^{f}\pm1.29$	$658^{d}\pm4.45$	$1074^{d}\pm2.80$	$89.65^{a}\pm3.02$	$5.20^{a}\pm3.05$

WF, wheat flour; PV, Peak viscosity; TV, Trough viscosity; BV, Breakdown viscosity; SV, Setback viscosity; FV, Final viscosity; P Temp, Pasting temperature; P Time, Peak time. F1 (90% wheat flour and 10% *C. album* flour); F2 (80% wheat flour and 20% *C. album* flour); F3 (70% wheat flour and 30% *C. album* flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% *C. album* flour).Means with different superscript in the same column are significantly different at $p<0.05$.Values are means ± standard deviation of triplicates

Table 4. Antioxidant activity, total phenolic and flavonoid content of wheat-*C.album* blend flour

Samples	AOA (%)	TPC (mg/100g)	TFC (mg/g)
Control (100g WF)	$4.83^{f}\pm1.02$	$15.70^{f}\pm0.30$	$1.99^{f}\pm0.09$
(F1)	$6.24^{e}\pm0.47$	$16.30^{e}\pm0.75$	$2.28^{e}\pm0.20$
(F2)	$7.85^{d}\pm1.06$	$28.50^{d}\pm0.82$	$2.47^{d}\pm0.37$
(F3)	$9.10^{c}\pm0.96$	$39.50^{c}\pm0.58$	$2.70^{c}\pm0.46$
(F4)	$9.58^{b}\pm1.67$	$62.30^{b}\pm1.21$	$2.80^{b}\pm0.50$
(F5)	$9.87^{a}\pm1.34$	$83.40^{a}\pm3.09$	$3.10^{a}\pm0.80$

F1 (90% wheat flour and 10% C. album flour); F2 (80% wheat flour and 20% C. album flour); F3 (70% wheat flour and 30% C. album flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% C. album flour). AoA, antioxidant activity; TPC and TFC, total phenolic and flavonoid content. Means with different superscript in the same column are significantly different at $p<0.05$. Values are means ± standard deviation of triplicates

Table 5. Physical and textural characteristics of wheat-*C. album* cookies

Samples	Parameters					
	Weight (g)	Thickness 'T'(mm)	Diameter 'W'(mm)	Spread ratio 'W/T'	Bake loss (g/100g)	Hardness (N)
Control (100g WF)	$11.93^{f}\pm0.50$	$7.10^{f}\pm0.16$	$52.07^{a}\pm1.10$	$7.33^{a}\pm0.63$	$18.33^{a}\pm1.10$	$52.50^{a}\pm0.63$
(F1)	$12.42^{e}\pm0.97$	$7.24^{e}\pm0.64$	$50.11^{b}\pm1.17$	$6.92^{b}\pm0.57$	$17.05^{b}\pm1.26$	$43.60^{b}\pm0.48$
(F2)	$12.74^{d}\pm0.30$	$7.56^{d}\pm0.39$	$48.80^{c}\pm0.89$	$6.45^{c}\pm0.89$	$15.82^{c}\pm0.85$	$31.60^{c}\pm0.72$
(F3)	$13.08^{c}\pm0.44$	$7.84^{c}\pm0.44$	$46.47^{d}\pm0.99$	$5.92^{d}\pm0.25$	$14.26^{d}\pm0.50$	$28.24^{d}\pm0.53$
(F4)	$13.33^{b}\pm0.18$	$8.04^{b}\pm0.56$	$43.72^{e}\pm1.07$	$5.43^{e}\pm0.50$	$12.45^{e}\pm0.5$	$27.71^{e}\pm0.49$
(F5)	$13.58^{a}\pm0.64$	$8.33^{a}\pm0.83$	$40.36^{f}\pm0.72$	$4.84^{f}\pm0.46$	$11.67^{f}\pm0.07$	$27.56^{f}\pm0.73$

F1 (90% wheat flour and 10% *C. album* flour); F2 (80% wheat flour and 20% *C. album* flour); F3 (70% wheat flour and 30% *C. album* flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% *C. album* flour). Means with different superscript in the same column are significantly different at $p<0.05$. Values are means ± standard deviation (n=6)

IJARSE
ISSN: 2319-8354

Table 6. Color analysis of wheat-*C. album* cookies

Samples	Colour		
	L*	a*	b*
Control (100g WF)	$60.10^{a}\pm2.22$	$6.33^{f}\pm0.20$	$28.03^{a}\pm0.09$
(F1)	$49.50^{b}\pm0.61$	$6.73^{e}\pm0.05$	$27.10^{b}\pm0.15$
(F2)	$48.70^{c}\pm0.14$	$7.10^{d}\pm0.16$	$26.60^{c}\pm0.12$
(F3)	$42.10^{d}\pm0.25$	$7.80^{c}\pm0.12$	$26.16^{d}\pm0.27$
(F4)	$39.90^{e}\pm0.34$	$8.20^{b}\pm0.15$	$25.46^{e}\pm0.16$
(F5)	$34.40^{f}\pm0.05$	$8.64^{a}\pm0.11$	$24.88^{f}\pm0.98$

F1 (90% wheat flour and 10% *C. album* flour); F2 (80% wheat flour and 20% *C. album* flour); F3 (70% wheat flour and 30% *C. album* flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% *C. album* flour).

Means with different superscript in the same column are significantly different at $p<0.05$. Values are means ± standard deviation (n=6)

Table 7. Sensory analysis of wheat-*C. album* cookies cookies

	Parameters					
Samples	Color & Appearance	Aroma	Taste	Mouth feel	Texture	OA
*Control (100g WF)	$7.50^{a}\pm0.50$	$7.75^{a}\pm0.60$	$7.75^{a}\pm0.40$	$7.50^{a}\pm0.77$	$6.50^{d}\pm0.75$	$7.75^{a}\pm0.50$
(F1)	$7.25^{b}\pm0.25$	$7.75^{a}\pm0.26$	$7.50^{b}\pm0.34$	$6.75^{b}\pm0.15$	$7.00^{c}\pm0.57$	$7.50^{b}\pm0.17$
(F2)	$7.25^{b}\pm0.75$	$7.50^{b}\pm0.17$	$7.50^{b}\pm0.76$	$6.75^{b}\pm0.12$	$7.25^{b}\pm0.95$	$7.50^{b}\pm0.09$
(F3)	$7.00^{c}\pm0.36$	$7.25^{b}\pm0.56$	$7.25^{c}\pm0.14$	$6.50^{c}\pm0.10$	$7.25^{b}\pm0.26$	$7.25^{c}\pm0.22$
(F4)	$7.00^{c}\pm0.17$	$7.25^{b}\pm0.88$	$7.25^{c}\pm0.62$	$6.50^{c}\pm0.43$	$7.50^{a}\pm0.14$	$7.25^{c}\pm0.38$
(F5)	$6.75^{d}\pm0.09$	$7.00^{c}\pm0.90$	$6.50^{d}\pm0.50$	$6.25^{d}\pm0.89$	$7.50^{a}\pm0.32$	$6.50^{d}\pm0.89$

WF, wheat flour; OA, Overall acceptability. Means with different superscript in the same column are significantly different at $p<0.05$.

LIST OF FIGURES:

Fig. 1 Pasting characteristics of of wheat-*C.album* blend flour

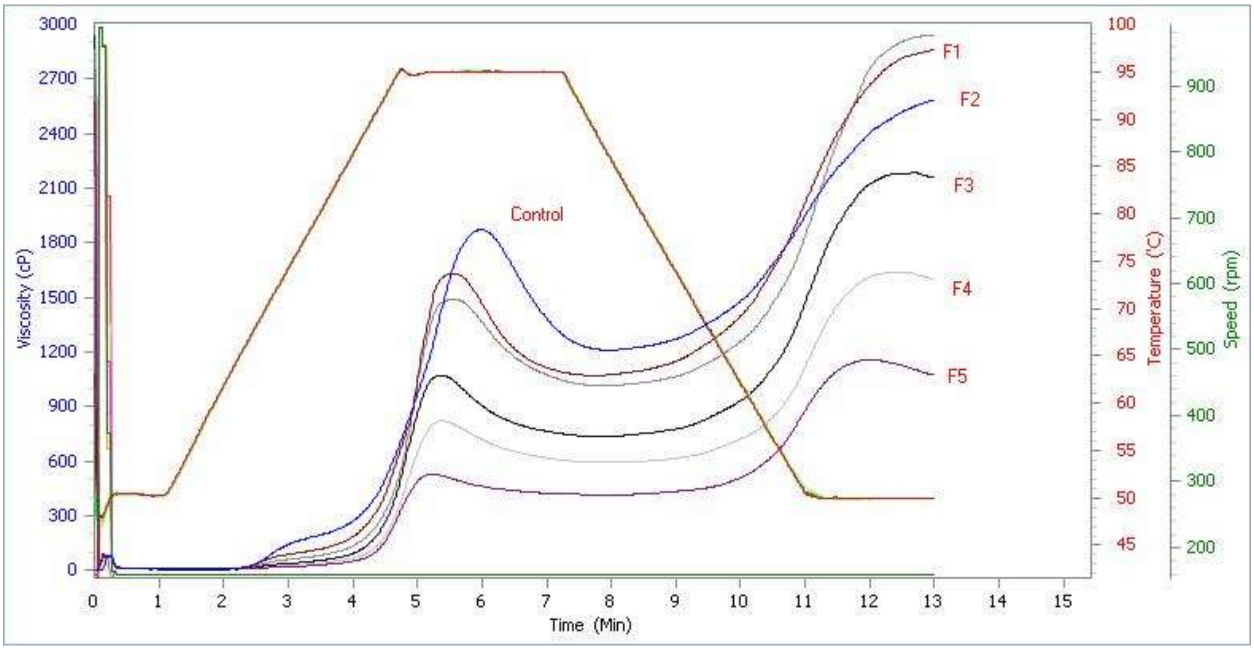

Fig. 1 Pasting characteristics of of wheat-*C.album* blend flour.

Control, Wheat flour; PV, Peak viscosity; TV, Trough viscosity; BV, Breakdown viscosity; SV, Setback viscosity; FV, Final viscosity; P Temp, Pasting temperature; P Time, Peak time. F1 (90% wheat flour and 10% *C. album* flour); F2 (80% wheat flour and 20% *C. album* flour); F3 (70% wheat flour and 30% *C. album* flour); F4 (60% wheat flour and 40% *C. album* flour); F5 (50% wheat flour and 50% *C. album* flour).