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Rheological and Sensory Attributes of Wheat, Quinoa and Buckwheat Composite Flour and their Use in Bakery Products

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Pseudo cereals like Quinoa and Buckwheat are not true cereals because they have only structural and compositional resemblances with true cereals. These cereals are largely grown in all over the world. They are very important due to their excellent nutritional contents especially protein and bioactive components. Cookies were prepared by making composite flour of quinoa, buckwheat and wheat. Six treatments were prepared by adding 10%, 20% and 30% of quinoa flour with whole-wheat flour and buckwheat flour with whole-wheat flour along with controlled treatment T_o (100% wheat flour). Composite flours were analyzed for proximate, chemical and rheological properties. Cookies were subjected to sensory evaluation, chemical analysis, physical and textural analysis. Treatments such as 90% wheat flour + 10% buckwheat flour (T_1), and 90% wheat flour + 10% quinoa flour (T_4), showed best results in comparison with all other treatments. The cookies of treatment T_1 and T_4 for texture and color analysis showed best results as compared to other treatments. The proximate results of cookies showed that T_1 and T_4 contain 13.27%, 13.32% moisture content, 13.43%, 13.38% protein content, 22.12%, 30.08% fat content, 1.7%, 1.87% crude fiber and 1.01%, 1.19% ash content respectively. Sensory results of cookies evaluated that T_1 of buckwheat and T_4 of quinoa showed the best results. Furthermore, a bitter taste of cookies was developed in 80% wheat flour + 20% buckwheat flour (T_2), 70% wheat flour + 30% buckwheat flour (T_3) of buckwheat and 80% wheat flour + 20% quinoa flour (T_5), 70% wheat flour + 30% quinoa flour (T_6) of quinoa treatments. The collected data was subjected to statistical analysis to check the significance of the results.
in hot water extract.

Key words: Buckwheat, Cookies, Quinoa, Rheological properties, Wheat.

Introduction

The pseudo cereals are not cereals, as they have only structural and compositional resemblances and they are gluten free, so they possess inferior baking properties. Buckwheat (*Fagopyrum esculentum*) mostly used for patients suffering from celiac diseases and has anti-carcinogenic as well as anti-mutagenic effects (Kim et al., 2004). Its flour may reduce different diseases like hypercholesterolemia, diabetes, hypertension and obesity. Buckwheat has excellent antioxidant activity because it contains hyperin, rutin, quercetin and catechins, which possess many health benefits. It is gluten free due to which it is used for persons with celiac diseases (Inglett et al., 2009). It contains fiber, magnesium, manganese, protein, copper, potassium, selenium and niacin (Jubete et al., 2010; Nascimento et al., 2014).

The important example of dietary fiber is hydrocolloids which contain strong gelling and structure binding properties and can improve the quality of gluten free products (Capriles and Areas, 2014). Phenolic contents can vary from variety to variety due to environmental conditions during plant growth (Guo et al., 2011). Quinoa is a major source of minerals, vitamins, flavonoids, polyphenols, saponins, and phytosterols with desired advantage of nutraceutical food products (Mastebroek et al., 2000). There are several findings on quinoa seeds showing its fatty acid compositions, compositional reserves, mineral contents, and chemical description of protein content and nutritional properties (Ogungbenle, 2003; Ogungbenle et al., 2009). It is a good source of protein for the people who are vegetarians because it contains protein contents about 13.1g/100g and minerals (Mota et al., 2014). Total fiber contents for quinoa are almost 10% that is highly important for diet food to reduce the risk of obesity and cardiovascular diseases (Lamothe et al., 2014).

Quinoa significantly known as pseudo cereal crop having high amount oil contents that contain almost 50.2% omega 6 fatty acids while 721.4 ppm and 797.2 ppm concentrations of alpha and gamma tocopherol respectively. It is very good source of energy for young and old people who are trying to reduce their weight by reducing the cholesterol level in blood and enhances the process of digestion in the body (Repo-Carrasco et al., 2003).

A very little study has been carried out on the rheological and pasting characteristics of wheat, quinoa and buckwheat composite flours. Rheological characteristics have been reported in fermented flour of buckwheat to form noodles. It was concluded that the fermented buckwheat should be utilized as a major food material and it is helpful in the

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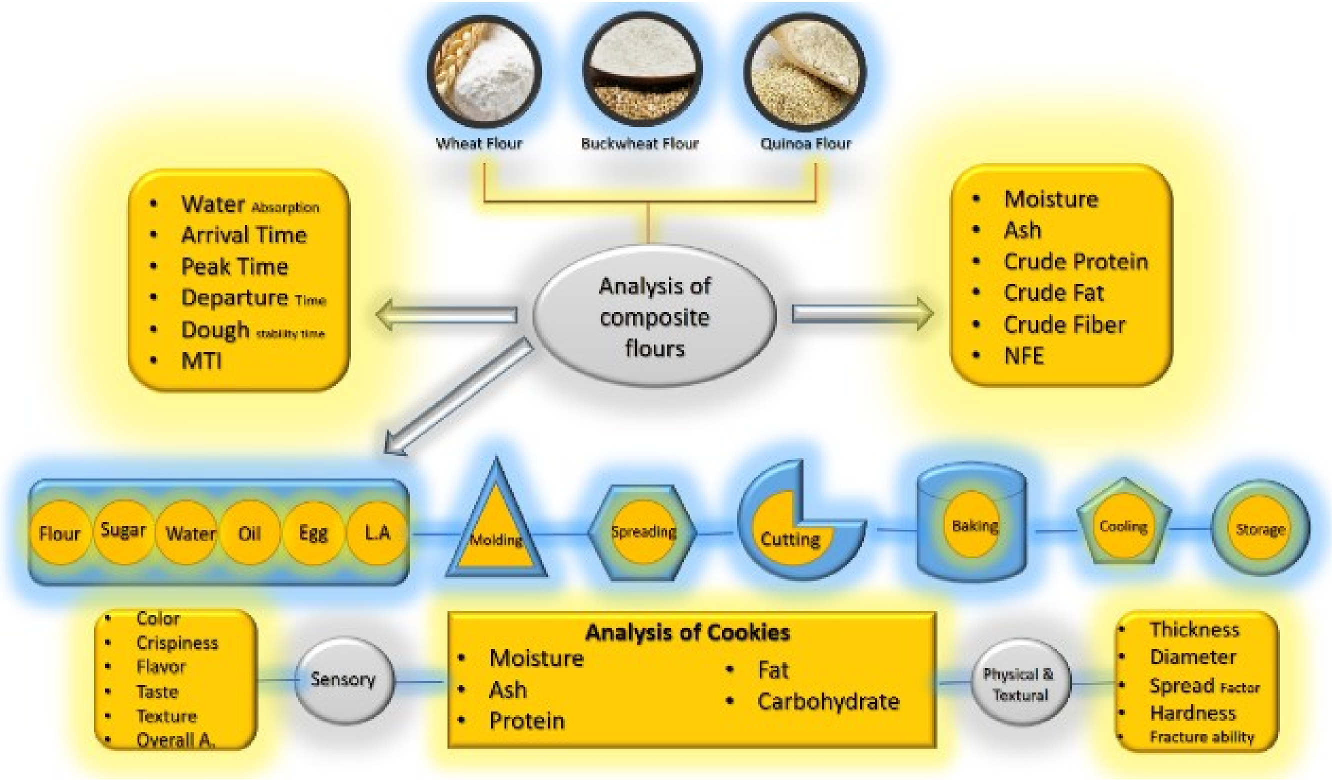

Scheme 1. Schematic diagram of wheat, quinoa, buckwheat flours and cookies.

production of hypoallergenic buckwheat, which is a new food ingredient (Handoyo et al., 2006; Kim et al., 2004).

The rheological and viscoelastic characteristics of bread batter were studies with an increasing quantity of quinoa (Turkut et al., 2016). The quality of bread was also estimated by examining the sensory, chemical and physical characteristics. The added quantity of quinoa flour did not show remarkable difference on the percentage of bake loss, protein value and the specific volume. However, the bread having 25% quinoa flour exhibited better results including high scores of sensory and softer texture. Therefore, the flours mixture of buckwheat and quinoa will be a better substitute for the formulations of gluten free bread (Turkut et al., 2016).

In previous studies, the rheological properties were examined by using dehulled seeds of quinoa after the removal of saponin contents in wheat bread. The results exposed that the rheological characteristics of the dough were increased when the quinoa seeds were incorporated around 20%. The product analysis revealed that the protein content was also increased in the bread up to 2%, showing the best sensory attributes with 20% incorporation of quinoa (Stikic et al., 2012). The rheological properties using mutual influence of xanthan gum on batter and bread were examined (Zeladaa et al., 2018). For this purpose, water and xanthan gum were added in quinoa, rice and maize flours using different ratios. The bread showed better appearance in terms of volume, less hardness of the crumb, greater springiness and visual texture of open grain, possessing 1.5 to 2.5% xanthan gum with greater percentage of water (Zeladaa et al., 2018). Some studies have also been conducted on starch which is a main component of buckwheat to estimate its physicochemical characteristics (Yo-shimoto et al., 2004), but the pasting and rheological characteristics of whole flour of buckwheat and quinoa were not studied yet.

In this study, we observed the rheological, physicochemical and sensory attributes of the wheat, quinoa, buckwheat, their composite flours and cookies, by treatments asT_0 (control), T_1, T_2 and T_3 with 10%, 20%, 30% of buckwheat flour while T_4, T_5 and T_6 with 10%, 20%, 30% of quinoa flour.

Schematic diagram of wheat, quinoa, buckwheat flours and cookies is shown in scheme 1.

Materials and methods

Procurement of raw material

Wheat, Quinoa and Buckwheat flours were procured from Ayyub Agriculture Research Institute (AARI) and University of Agriculture, Faisalabad while other materials like sugar, fat, baking powder required for cookie making were purchased from local market.

Preparation of composite flours

The composite flours were prepared with the incorporation of quinoa and buckwheat flour in 10, 20 and 30% concentration with wheat flour as shown in treatment plan (Table 1).

Rheological properties

In rheological properties the farinographic study of different doughs prepared from wheat flour, quinoa flour and buckwheat flour were investigated by using a farinograph at 25 ºC and compared with those of standard dough (without addition of pseudo cereals). The following characteristics were determined: water absorption capacity, dough development time, dough stability and mixing tolerance index.

Table1
Treatment plan.

Treatments	Wheat flour (%)	Buckwheat flour (%)	Quinoa flour (%)
To	100	---	---
T_1	90	10	---
T_2	80	20	---
T_3	70	30	---
T_4	90	---	10
T_5	80	---	20
T_6	70	---	30

Product development
The cookies were prepared with the incorporation of quinoa flour (QF) and buckwheat flour (BWF) in 10, 20 and 30% level with wheat flour (WF) keeping sugar and fat amount constant to 55gm and 42gm respectively on 100gm flour basis. First of all, creaming was done for 10 minutes by adding shortening and sugar. Then eggs were added and mixing was done for few minutes. The composite flours and leavening agent were added after mixing. Then molding was done and measured weight, height and diameter. The kneaded dough was sheeted to a thickness 7mm using cookie table. The cookies were cut with a die to desired diameter and transferred to a lightly greased aluminum baking tray. The cookies were baked at 200 °C for 12 min in a baking oven. The baked cookies were cooled for few minutes and stored in an airtight container for further analysis. Seven different types of cookies were prepared at various concentrations, containing a standard and 10, 20 and 30% buckwheat or quinoa flours.

Physical analysis of cookies
Diameter of cookies were measured by laying six cookies edge to edge with the help of a scale rotating them 90° and again measuring the diameter of six cookies (cm) and then taking average value. The cookies thickness (cm) was measured by taking the average thickness of six different cookies and then the average of diameter was divided by the average thickness to calculate spread ratio. The spread ratio of supplemented and control cookies was further divided and multiply by 100 to estimate the percent spread.

Compositional Analysis
Protein (Kjeldahl, N× 6.25), (method number 992.15 (39.1.16), fat (method number 954.02), (solvent extraction), moisture (method number 934.01), ash (method number 942.05), and crude fiber (method number 978.10) of quinoa flour, buckwheat flour, wheat flour, their compositional flours and formulated cookies were determined by AOAC (2000) methods. The carbohydrate content was also calculated by subtraction method AOAC (2000).

$$Total\ carbohydrates = 100 - (crude\ fat + crude\ protein + ash + moisture + crude\ fiber)$$

Texture analysis
All texture analysis was done according to Piga et al. (2005) by using texture analyzer (Mod. TA-XT2, stable micro system, Surrey, UK) interfaced with a computer, which controls the instrument and records the data. To compare the hardness and fracturability of cookies, 2 mm cylinder probe (P/2) using 5 kg load cell equipped with heavy-duty platform (HDP/90) was used and for the data analysis, the Texture Exponent 32 programme, version 4.0.9.0, was used. Pre-test, test, and post-test speeds were 1.5, 2, and 10 mm/s, respectively. Three repeated measurements were taken for every formulation, and mean values were calculated.

Sensory evaluation
The cookies were evaluated by a panel of judges from National Institute of Food Science and Technology, University of Agriculture Faisalabad for color, flavor, texture, taste, crispiness and over all acceptability according to procedure described by Meilgaard et al. (2007).

Statistical analysis
The data obtained for each parameter were subjected to statistical analysis to determine the level of significance between quality parameters of different composite flours by using analysis of variance complete randomized design to check the level of significance ($p<0.05$) among the treatments and means were compared according to the appropriate methods described by Steel et al. (1997).

Results and Discussions

Chemical composition of composite flours
The chemical compositions of flours are presented in (Table.2). It showed that the content of fat and moisture of flours did not vary remarkably. However, a considerable variation was observed in the crude protein content, ash content, crude fiber and carbohydrate content of composite flours. The flour of buckwheat and quinoa possessed higher content of protein (16.71%) and (15.96%) respectively as compared to the wheat flour (13.12%). The protein content of buckwheat flour ranges from 8.5% to 19% depending on its variety, applied fertilizer and pesticide used (Khan et al., 2013). Quinoa flour possess highest amount of fat (5.72%) as compared to wheat and buckwheat (Valcarcel-Yamani et al., 2012). In composite flours ash and protein contents increased as we increased the quantity of buckwheat and quinoa flours.

Table 2
Compositional analysis of flours.

Parameter (%)	Wheat flour	Buckwheat flour	Quinoa flour
Moisture	13.65±0.03	11.63±0.04	11.25±0.02
Ash	0.98±0.02	1.60±0.02	3.27±0.03
Crude protein	13.12±0.02	16.71±0.03	15.96±0.03
Crude Fat	3.94±0.02	1.48±0.03	5.72±0.02
Crude fiber	1.86±0.03	0.72±0.02	2.71±0.01
Nitrogen free extract (NFE)	66.45±0.07	67.86±0.1	61.09±0.05

All the readings were taken in triplicates at ($p<0.05$).

Crude fat and fiber contents decreased with the increasing concentration of buckwheat while increased during the addition of quinoa flour because quinoa flour is rich in fat.

Rheological properties

Some physical and micro structural variations take place when wheat flour is supplemented with some other flours e.g. buckwheat flour and quinoa flour. It has been reported that the rheological properties of the dough can predict the performance of materials during processing. Therefore, rheological characteristics of wheat dough and the dough enriched with buckwheat and quinoa flour was observed by using farinograph. It was observed that with the increase in buckwheat or quinoa flour concentration in wheat flour, the water absorption of flour significantly decreased (Table.3).

The highest amount of water absorption observed in T_o, T_1 and T_4 was around 60.77, 59.83 and 57.70 respectively, which is mainly due to the presence of water absorbing compounds known as arabino-xylans. The dough development time is usually the time which shows the most appropriate consistency of the dough. It gradually decreased with the increase in the concentration of the buckwheat and quinoa flours. Buckwheat and quinoa are gluten free so they can decrease the dough stability due to unavailability of gluten. The maximum stability of dough (7.51 min) was observed in wheat flour. It was reported by Maeda (2006) that substitution of buckwheat flour should not be performed at higher (>30 %) levels because it can clearly reduce the sensory properties and strength of the dough.

Compositional analyses of cookies

The compositional analyses of cookies are given in (Table.4). An increasing trend is observed in the crude protein content of cookies with the increase in the level of buckwheat or quinoa flour supplementation. The highest values of crude protein content (14.13%) were observed in the cookies having 30% buckwheat flour supplementation while (13.94%) were observed in the cookies having 30% quinoa flour supplementation. The ash content also increased due to the buckwheat or quinoa flour addition. The content of fiber decreased due to the addition of buckwheat flour, while increased due to the addition of quinoa flour. The content of moisture decreased due to the increasing trend of quinoa or buckwheat. The flour of buckwheat has a unique property of oil retention during baking process. The content of carbohydrate as measured by the method of difference was found to be greater in 70% wheat flour + 30% buckwheat flour and 90% wheat flour + 10% quinoa flour cookies.

Physical and textural characteristics of cookies

The physical analyses of cookies made by wheat, quinoa and buckwheat flour were observed (Table 5).

Table 3

Rheological properties of the composite flours.

Parameter	Water Absorption	Arrival time	Peak time	Departure time	Dough stability time	Mixing tolerance index
T_0	$60.77±0.03^{g}$	$1.44±0.02^{a}$	$3.24±0.02^{a}$	$8.69±0.03^{a}$	$7.51±0.02^{a}$	$76.67±0.02^{a}$
T_1	$59.83±0.03^{f}$	$1.32±0.01^{b}$	$3.05±0.03^{b}$	$8.1±0.02^{b}$	$6.99±0.02^{b}$	$74.42±0.02^{b}$
T_2	$59.05±0.03^{d}$	$1.24±0.02^{c}$	$2.93±0.03^{c}$	$7.44±0.02^{d}$	$6.33±0.02^{d}$	$72.13±0.03^{c}$
T_3	$58.14±0.03^{a}$	$1.15±0.03^{d}$	$2.81±0.01^{d}$	$6.79±0.02^{e}$	$5.61±0.03^{e}$	$69.93±1.12^{d}$
T_4	$57.70±0.02^{e}$	$1.28±0.03^{c}$	$3.02±0.04^{e}$	$7.54±0.01^{b}$	$6.95±0.01^{b}$	$75.09±0.03^{c}$
T_5	$56.92±0.01^{c}$	$1.22±0.02^{b}$	$2.92±0.02^{d}$	$7.46±0.03^{c}$	$6.45±0.02^{b}$	$72.83±0.02^{b}$
T_6	$56.01±0.02^{b}$	$1.13±0.01^{a}$	$2.83±0.01^{b}$	$6.88±0.04^{d}$	$5.81±0.04^{d}$	$70.34±0.01^{e}$

p=0.05.The same superscripts are non-significant, while the different one are significant.
The data obtained from three different replicates.

Table 4

Compositional analyses of cookies.

Samples	**Moisture (%)**	**Ash (%)**	**Protein (%)**	**Fat (%)**	**Fiber (%)**	**Carbohydrate (%)**
T_0	$14.22±0.03^{a}$	$1.44±0.02^{ab}$	$11.13±0.05^{f}$	$28.76±0.02^{d}$	$1.44±0.03^{e}$	$43.01±0.06^{d}$
T_1	$13.27±0.02^{b}$	$1.01±0.02^{e}$	$13.43±0.02^{e}$	$22.12±0.05^{e}$	$1.7±0.03^{c}$	$48.47±0.01^{c}$
T_2	$13.15±0.01^{c}$	$1.07±0.02^{de}$	$13.76±0.03^{c}$	$21.55±0.03^{f}$	$1.54±0.02^{d}$	$48.92±0.04^{b}$
T_3	$12.97±0.04^{de}$	$1.13±0.02^{cd}$	$14.13±0.04^{a}$	$19.65±0.01^{g}$	$1.48±0.03^{de}$	$50.64±0.05^{a}$
T_4	$13.32±0.02^{b}$	$1.19±0.02^{c}$	$13.38±0.02^{e}$	$30.08±0.02^{c}$	$1.87±0.03^{b}$	$40.16±0.05^{e}$
T_5	$13.05±0.03^{d}$	$1.41±0.02^{b}$	$13.61±0.02^{d}$	$31.64±0.03^{b}$	$1.98±0.02^{a}$	$38.31±0.11^{f}$
T_6	$12.89±0.08^{e}$	$1.49±0.02^{a}$	$13.94±0.02^{b}$	$32.93±0.04^{a}$	$2.04±0.02^{a}$	$36.71±0.07^{g}$

Table 5
Physical and Textural analyses of cookies.

Samples	Thickness (mm)	Diameter (mm)	Spread factor (mm)	Hardness (kg)	Fracture ability (mm)
T_0	37.80±0.03[a]	133.68±0.03[g]	35.62±0.02[f]	1.22±0.04[g]	37.51±0.03[e]
T_1	36.43±0.04[e]	138.89±0.05[f]	38.55±0.03[e]	4.47±0.03[f]	36.14±0.02[f]
T_2	36.93±0.04[c]	141.07±0.02[e]	39.85±0.03[d]	4.73±0.04[e]	38.26±0.04[d]
T_3	37.15±0.02[b]	143.37±0.04[c]	40.54±0.04[c]	4.92±0.03[d]	38.35±0.04[d]
T_4	35.97±0.03[f]	142.31±0.03[d]	41.48±0.03[c]	5.11±0.02[c]	38.46±0.02[c]
T_5	36.53±0.04[d]	144.11±0.04[b]	42.89±0.03[b]	5.36±0.03[b]	39.31±0.03[b]
T_6	37.02±0.03[c]	145.51±0.04[a]	44.26±0.03[a]	5.64±0.02[a]	40.15±0.03[a]

All the readings were taken in triplicates at (p=0.05).

The thickness, diameter, hardness and fracture ability of the cookies were increased by increasing the level of buckwheatflour or quinoa flour. Cookies having 30% buckwheat or quinoa flour possessed higher values of thickness, diameter and possess the maximum value of hardness (4.92kg for 30% buckwheat and 5.64 kg for 30% quinoa flour cookies) compared to control samples. The buckwheat cookies thickness ranged from 36.43 mm to 37.15 mm and the quinoa cookies thickness ranged from 35.97 mm to 37.02 mm while the thickness of controlled cookies was 37.80 mm.

The variation in thickness and diameter of the cookies were depicted in the spread ratio. When the concentration of buckwheat flour and quinoa flour increased then the spread factor also increased significantly. Spread factor ranged from 38.55 mm to 40.54 mm for buckwheat cookies and 41.48 mm to 44.26 mm for quinoa cookies. It was found that the value of spread factor decreased by increasing the concentration of buckwheat flour in cookies. A significant increase was also observed in the fracture ability of cookies. The value of cookies fracture ability ranges from 36.14mm to 38.35mm for buckwheat cookies while 38.46mm to 40.15mm for quinoa cookies (Mudgil, Barak et al. 2017).

Sensory characteristics of cookies

Figure.1 shows the effects of buckwheat and quinoa flour supplementation on sensory properties of cookies. Sensory scores for crispiness, flavor, taste and texture of cookies reduced with the increasing level of buckwheat or quinoa flour supplementation in formulation. The scores of color reduced significantly with the increasing level of buckwheat or quinoa flour because they had higher values of yellowness and lower lightness (Mudgil, Barak et al. 2017). Score of cookies prepared from 100% wheat flour was higher as compared to the buckwheat or quinoa flour incorporated cookies. While the score of texture decreased to 5.1 due to the cracks formation on the surface of cookies with the accumulation of gluten less flour of buckwheat while 5.2 for the cookies having 30% quinoa flour concentration. The flavor score decreased significantly to 4.5 and 5.0 at higher supplementation level of buckwheat flour or quinoa flour respectively. The cookies prepared with 10% buckwheat and quinoa flour supplementation got highest scores of overall acceptability.

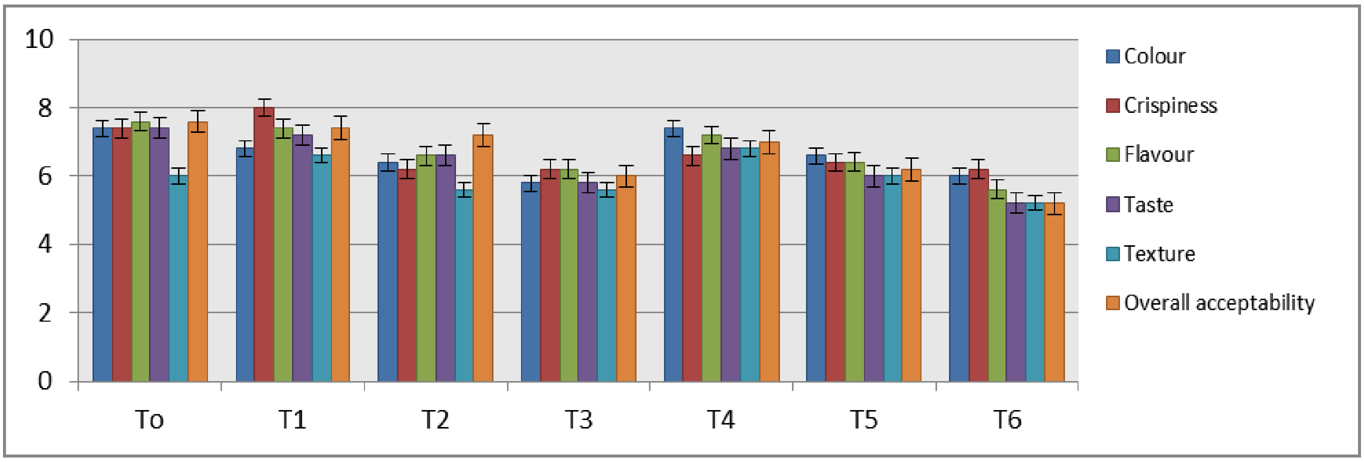

Figure 1. Sensory characteristics of cookies supplemented with buckwheat flour and quinoa flour.
All the readings were taken in triplicates at (p=0.05)

Conclusions

In this study, rheological properties of wheat, buckwheat and quinoa doughs and sensory properties of cookies prepared from their compositional flours were studied. According to the results, we can conclude that T_1 and T_4 in which 10 % buckwheat and 10% quinoa incorporated respectively, showed the best results as compared to other treatments. They possessed good nutritional and health benefits as well as have high sensory acceptability. In other treatments as we increased the quantity of buckwheat and quinoa up to 20% and 30% then the cookies showed a bitter taste. This shows a potential way to make different kinds of foods for gluten intolerance persons as well as others can also have nutritionally rich foods.

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References

Ando, H., Chen, Y. Tang, H. Shimizu, M. Watanabe, K. and Miysunaga, T. (2002). Food components in fractions of quinoa seed. *Food Science and Technology Research,* 8: 80-84.

AOAC (1980). Official Methods of Analysis, 15th Edition, Association of Official Analytical Chemists, Washington, DC.

AOAC (2000). Official Methods of the Association of Official Chemists. Official Analytical Int, ArlingtonVA. Change of bacterial community. *Journal of Microbiology and Biotechnology,* 18: 1518-1521.

Abugoch, L., Romero, N. Tapia, C. Silva, J. and Rivera, M. (2008). Study of some physicochemical and functional properties of quinoa (*Chenopodium quinoa Willd.*) protein isolates. *Journal of Agriculture and Food Chemistry*, 56: 4745-4750.

Bhargava, A., Rana, T. Shukla, S. and Ohri, D. (2005). Seed protein electrophoresis of some cultivated and wild species of chenopodium. *Biologia Plantarum*, 49: 505-511.

Capriles, V.D. and Areas, J.A.G. (2014). Novel approaches in gluten-free bread making: interface between food science, nutrition, and health. *Comprehensive Reviews in Food Science and Food Safety*, 13: 871-890.

Guo, X.D., Ma, Y.J. Parry, J. Gao, J.M. Yu, L.L. and Wang, M. (2011). Phenolic contents and antioxidant activity of tartary buckwheat from different locations. *Molecules*, 16: 9850-9867.

J.M. Gee, Price, K.R. Ridout, C.L. Wortley, G.M. Hurrel, R.F. and Johnson, I.T. (1993). Saponins of quinoa (*Chenopodium quinoa*): Effects of processing on their abundance in quinoa products and their biological effects on intestinal mucosal tissue. *The Journal of the Science of Food and Agriculture,* 63. 201-209.

Handoyo, T., Maeda, T. Urisu, A. Adachi, T. and Morita, M. (2006). Hypoallergenic buckwheat flour preparation by *Rhizopus oligosporus* and its application to soba noodle. *Food Research International*, 39: 598-605.

Inglett, G.E., Xu, J. Stevenson, D.G. and Chen, D. (2009). Rheological and pasting properties of buckwheat (*Fagopyrum esculentum Moench*) flours with and without jet-cooking. *Cereal Chemistry*, 86: 1-6.

Jubete, A.L., Arendt, E.K. and Gallagher, E. (2010). Nutritive value of pseudo cereals and their increasing use as functional gluten-free ingredients. *Trends in Food Science and Technology*, 21: 106-113.

Khan, F., Arif, M. Khan, T.U. Khan, M.I. and Bangash, J.A. (2013). Nutritional evaluation of common buckwheat of four different villages of gilgit-baltistan. *ARPN Journal of Agricultural and Biological Science*, 8(3): 264-266.

Kim, S.L., Kim, S.K. and Park, C.H. (2004). Introduction and nutritional evaluation of buckwheat sprouts as a new vegetable. *Food Research International*, 37: 319-327.

Lamothe, L.M., Srichuwong, S. Bradley, L. Reuhs, L. and Hamaker, B.R. (2014). Quinoa (*Chenopodium quinoa Willd.*) and amaranth (*Amaranthus caudatus L.*) provide dietary fibres high in pectic substances and xyloglucans. *Food Chemistry*, 167: 490-496.

Mastebroek, D., Limburg, H. Gilles, T. and Marvin. H. (2000). Occurrence of sapogenins in leaves and seeds of quinoa (*Chenopodium quinoa Willd.*). *The Journal of the Science of Food and Agriculture,* 80: 152-156.

Meilgaard, M.C. and Civileand, G.V. (2007). Sensory Evaluation Techniques, 4th Edition CRC Press, New York, USA.

Mota, C., Santos, M. Mauro, R. Samman, N. Matos, A.S. Torres, D. and Castanheira, I. (2014). Protein content and amino acids profile of pseudo cereals. *Food Chemistry*, 12: 54-58.

Mudgil, D., Shweta, B. and Khatkar, B.S. (2017). Cookie texture, spread ratio and sensory acceptability of cookies as a function of soluble dietary fiber, baking time and different water levels. *LWT- Food Science and Technology*, 80: 537-542.

Nascimento, A., Mota, C. Coelho, I. Gueifao, S. Santos, M. And Matos, S. (2014). Characterization of nutrient profile of quinoa (Chenopodium quinoa), amaranth (Amaranth caudatus), and purple corn (Zea mays L.) consumed in the north of argentina: Proximates, minerals and trace elements. *Food Chemistry*, 148: 420-426.

Ogungbenle, H. (2003). Nutritional evaluation and functional properties of quinoa (*Chenopodium quinoa*) flour. *International Journal of Food Science and Nutrition*, 54: 153-158.

Ogungbenle, H., Oshodi, A. and Oladimeji, M. (2009). The proximate and effect of salt applications on some functional properties of quinoa (*Chenopodium quinoa*) flour. *Pakistan Journal of Nutrition*, 8: 49-52.

Piga, A., Catzeddu, P. Farris, S. Roggio, A.T. and Sanguinetti, E.S. (2005). Texture evaluation of amaretti cookies during storage. *European Food Research and Technology*, 221: 387-391.

Repo-Carrasco, R., Espinoza, C. and Jacobsen, S.E. (2003). Nutritional value and use of the andean crops quinoa (*Chenopodium quinoa*) and kaniwa (*Chenopodium pallidicaule*). *Food Reviews International*, 19: 179-189.

Ruales, J. and Nair, B.M. (1993). Saponins, phytic acid, tannins and protease inhibitors in quinoa (*Chenopodium quinoa*, Willd) seeds. *Food Chemistry*, 48: 137-143.

Steel, R.G.D., Torrie, J.H. and Dickey, D.A. (1997). Principles and Procedures of Statistics. A biometrical approach. Singapore: 3rd Ed. McGraw Hill Book Co. Inc., New York. NY, USA.

Stikic, R., Djordje, G. Mirjana, D. Biljana, V.R. Zorica, J. Dusanka, M.O. Sven, E.J. Mirjana, M. (2012). Agronomical and nutritional evaluation of quinoa seeds (Chenopodium quinoa Willd.) as an ingredient in bread formulations. *Journal of Cereal Science*, 55: 132-138.

Turkut, G.M., Hulya, C. Seher, K. Sebnem, T. (2016). Effect of quinoa flour on gluten-free bread batter rheology and bread quality. *Journal of Cereal Science*, 69: 174-181.

Valcárcel-Yamani, B. and Lannes, S.D.S. (2012). Applications of quinoa (Chenopodium quinoa Willd.) and amaranth (Amaranthus spp.) and their influence in the nutritional value of cereal based foods. *Food and Public Health*, 2(6): 265-275.

Yo-shimoto, Y., Egashira, T. Hanashiro, I. Ohinata, H. Takase, Y. and Takeda, Y. (2004). Molecular structure and some physicochemical properties of buckwheat starches. *Cereal Chemistry*. 81: 515-520.

Zeladaa, C.R.E., Vasco, C. Fernando, M. Jose, A.T. Ursula, G.B. (2018). Combined effect of xanthan gum and water content on physicochemical and textural properties of gluten-free batter and bread. *Food Research International*, 111: 544-555.