

## Elaboration, Physicochemical and Sensory Analysis of a Sweet Bread Made with Buckwheat and Fruit Flours

<sup>1</sup>C.S. Möller, <sup>2</sup>V.R. De Oliveira, <sup>1</sup>T.P. Amorim, <sup>1</sup>R.U. Thoen and <sup>3</sup>A. de O. Rios

<sup>1</sup>Universidade Federal do Rio Grande do Sul (UFRGS), Rio Grande do Sul, Brazil

<sup>2</sup>Department of Internal Medicine,

<sup>3</sup>Department of Food Science, Institute of Food Science and Technology (ICTA),  
Universidade Federal do Rio Grande do Sul (UFRGS), Rio Grande do Sul, Brazil

**Abstract:** The aim of this study was to evaluate the viability of new gluten free sweet bread, as well as their physicochemical features and acceptance. As more and more people become aware of coeliac disease, it is important to increase the options in terms of gluten free bakery products. The adaptation of bakery product-sweet bread-to gluten free versions can be justified for its role in preventing coeliac problems. Wheat flour was substituted by common buckwheat flour mixed with fruit flours and their physicochemical characteristics were evaluated, compared to standard sweet bread, with wheat flour in its composition. The passion fruit sweet bread had the highest percentage of humidity, with significant difference among the other formulations ( $p \leq 0.05$ ). Ash and lipids had the highest amount in the banana sample and proteins showed its highest value in the standard sweet bread ( $p \leq 0.05$ ). A sensory analysis was conducted, with good results. It was also evaluated the purchase intention, indicating that these products are not only viable, but worth buying.

**Keywords:** Bakery products, coeliac disease, *Fagopyrum esculentum* moench, gluten-free

### INTRODUCTION

Gluten is an elastic, fibrous substance, formed by the combination of flours proteins (such as gliadin and glutenin) and water, resulting in hydration and formation of a protein complex by disulphide and hydrogen bonds. Its purpose is to retain gases that are formed by fermentation, turning the dough/batter expandable but resistant to cracks, which makes possible for it to grow during bakery. Its other purpose is to retain humidity from the batter even after baking, helping to ensure its elasticity and softness (Wieser, 2007; Gallagher *et al.*, 2004). However, gluten comprises peptides, which cause autoimmune reactions on people with coeliac disease (Moore *et al.*, 2006). Among the extra-intestinal manifestations, there are iron deficiency anemia, hepatic steatosis, psychiatric syndromes, dental enamel hypoplasia and arthritis (Mahan and Escott-Stump, 2004).

An alternative to wheat is the common buckwheat (*Fagopyrum esculentum* Moench), which lacks gluten in its composition. Although called buckwheat due to its chemical composition similarities to wheat (Silva *et al.*, 2002), the buckwheat tends to the rice family.

It is a good source of fiber and, also contains flavonoids, such as rutin, which is known by its

antioxidant properties (Silva *et al.*, 2002; Yang *et al.*, 2008), polyunsaturated essential fatty acids, fagopyratol and sterols. It has a high rate of vitamins, amino acids and minerals (Kalinova and Dadakova, 2009). It also has functional components, which assists in the cholesterol and blood sugar regulation, reduces high blood pressure and even helps to prevent the risk of cancer (Wojcicki *et al.*, 1995; Kim *et al.*, 2004).

Sweet bread is originary from Germany, where it is known as kuchen and was brought to Brazil by immigrants, who settled firstly in the Vale dos Sinos-Rio Grande do Sul, spreading later to other parts of the state. During the years, the recipe went through changes, being adapted to local conditions and available ingredients, until it became the current version, traditionally in Rio Grande do Sul. Among the ingredients of sweet bread, wheat flour is the main one.

Due to the fact that there is gluten in its composition, coeliac people are not able to consume such dish. There are a lot of products that are gluten free and buckwheat is becoming a very common ingredient in products such as pasta, bread, cookies, noodles and spaghetti (Manthey *et al.*, 2004).

A sweet bread formulation bearing the characteristics of being gluten-free, easy to prepare and with a good acceptability would provide improvements

in the life quality of such patients, offering a wider range of food choices in their diet. Thus, this study will endeavor to produce a sweet bread formulation that attends these features.

## MATERIALS AND METHODS

The physical and sensory analysis were conducted in the Dietetic Technique Laboratory of the Nutrition course in the Medicine School (FAMED) of Universidade Federal do Rio Grande do Sul (UFRGS).

The sweet bread loafs were elaborated with wheat flour being replaced by common buckwheat flour mixed with passion fruit, apple or banana flour, resulting in three different gluten free formulations. Some changes had to be made to the original formulation in order to adapt the recipes to those flours during the tests. The ingredients used can be found in Table 1.

All ingredients were weighed using a Plenna® precision scale. The common buckwheat, passion fruit, apple or banana flours were available at the Dietetic Technique Laboratory of the Nutrition course in the Medicine School (FAMED) of Universidade Federal do Rio Grande do Sul (UFRGS). All the ingredients were bought at a local market, as was the standard sweet bread, made with wheat flour, which was used as control sample.

The elaboration consisted in firstly preheating the Dako® oven, Luna model. Then, egg whites were beaten with a Top Mixer mixer, Sield® brand. Using the same mixer, sugar, vegetable oil and the yolks were mixed until a cream was formed. Common buckwheat flour, each fruit flour, yeast and milk, were added to this cream, which was being mixed all along. When the batter was homogenized, the beaten egg whites were added, mixed slowly with a spreader. The batter was, then, poured on a greased baking dish and the sugar crust was added on top of it. The batter with the sugar crust was then taken to the Dako® oven, Luna model, at 180°C, for approximately 1 h.

For the sugar crust, the ingredients were homogenized in a metal bowl and mixed with the fingertips till it turned into many irregular “lumps”.

The physical analyses occurred at the Dietetic Technic Laboratory, where depth was measured with a scale in three different spots of each formulation already on their respective baking dish, before and after baking. The formulations were also weighted, three times each, before and after baking, using a precision scale.

The chemical analyses were conducted at the Bioactive Compounds Laboratory of the Institute of Food Science and Technology (ICTA) of Universidade Federal do Rio Grande do Sul (UFRGS). Moisture, ash, lipids, proteins analyses were performed following Adolfo Lutz Institute's protocols (2008), with three samples. For comparison parameters, a standard sweet bread loaf was used, bought at a local market.

The sensory analysis was conducted at the Dietetic Technic Laboratory and was performed by 36 non-trained, non-coeliac people, after signing an informed consent form. The participants of the survey were students and teachers from the university. The sweet bread loafs were evaluated in terms of global acceptance, texture, color, flavor and appearance. The sensory analysis was conducted isolated with each evaluator, at ambient temperature, using white plastic dishes, numbered with three random digits, which corresponded to each respective flours (passion fruit, apple, banana and wheat flour). The evaluators received water to drink before evaluating each sweet bread sample. A hedonic scale of 9 points was used, each point meaning:

- Dislike extremely
- Dislike very much
- Dislike moderately
- Dislike slightly
- Neither like or dislike
- Like slightly
- Like moderately
- Like very much
- Like extremely

Table 1: Sweet breads formulation

Ingredients	Banana sweet bread	Passion fruit sweet bread	Apple sweet bread	Household measures
Common buckwheat flour	300 g	300 g	300 g	2 full tea cups
Banana flour	180 g	-	-	1 full tea cup
Passion fruit flour	-	180 g	-	1 full tea cup
Apple flour	-	-	180 g	1 full tea cup
Eggs	2	2	2	-
Refined sugar	170 g	170 g	170 g	1 full tea cup
Vegetable oil	90 mL	90 mL	90 mL	1 full tablespoon
Biologic yeast	10 g	10 g	10 g	1 shallow tablespoon
Milk	600 mL	1200 mL	600 mL	2 full tea cups/4 full teacups
Sugar crust formulation				
Common buckwheat flour	80 g	80 g	80 g	4 full tablespoons
Banana flour	40 g	-	-	2 full tablespoons
Passion fruit flour	-	40 g	-	2 full tablespoons
Apple flour	-	-	40 g	2 full tablespoons
Butter	85 g	85 g	85 g	4 ½ tablespoons
Refined sugar	144 g	144 g	144 g	6 full tablespoons

Table 2: Physical analysis of gluten free and standard commercial sweet breads

Sweet bread samples	Raw weight (Kg)	Baked weight (Kg)	Raw depth (cm)	Baked depth (cm)	Baking time (min)
Passion fruit	2.09±0.01 <sup>a</sup>	2.26±0.01 <sup>a</sup>	3.06±0.1 <sup>a</sup>	4.53±0.1 <sup>a</sup>	72 <sup>a</sup>
Apple	1.82±0.01 <sup>b</sup>	2.00±0.01 <sup>b</sup>	2.63±0.1 <sup>a</sup>	4.43±0 <sup>a</sup>	64 <sup>b</sup>
Banana	1.48±0.01 <sup>c</sup>	1.78±0.01 <sup>c</sup>	2.50±0.1 <sup>a</sup>	3.63±0 <sup>b</sup>	60 <sup>c</sup>

Same superscript in same columns indicate that there is no significant difference between the results, for  $p \leq 0.05$

Table 3: Mean chemical composition of gluten free and standard commercial sweet breads in g %

Sweet bread samples	Moisture	Ash	Lipids	Proteins	Total fiber	Insoluble fiber	Soluble fiber
Passion fruit	46.57±0.08 <sup>a</sup>	1.05±0.02 <sup>a</sup>	8.12±0.47 <sup>b</sup>	1.05±0.04 <sup>c</sup>	14.51 <sup>a</sup>	12.72 <sup>a</sup>	1.79 <sup>a</sup>
Apple	31.51±1.17 <sup>c</sup>	0.38±0.02 <sup>c</sup>	8.95±0.28 <sup>b</sup>	1.44±0.14 <sup>b</sup>	5.80 <sup>b</sup>	5.10 <sup>b</sup>	0.07 <sup>c</sup>
Banana	37.11±1.30 <sup>b</sup>	1.08±0.53 <sup>a</sup>	11.30±0.93 <sup>a</sup>	1.51±0.01 <sup>b</sup>	4.53 <sup>c</sup>	4.49 <sup>c</sup>	0.04 <sup>d</sup>
Commercial sweet bread (standard)	17.90±0.85 <sup>d</sup>	0.86±0.07 <sup>b</sup>	7.80±0.39 <sup>b</sup>	2.18±0.08 <sup>a</sup>	2.37 <sup>d</sup>	0.80 <sup>d</sup>	1.57 <sup>b</sup>

Same superscript in same columns indicate that there is no significant difference between the results, for  $p \leq 0.05$

Table 4: Sensory analysis of gluten free and standard commercial sweet breads

Sweet bread samples	Global acceptability	Appearance	Color	Taste	Texture
Passion fruit	4.28±1.99 <sup>b</sup>	6.13±1.83 <sup>b</sup>	6.58±1.68 <sup>a</sup>	3.55±1.82 <sup>c</sup>	5.69±2.29 <sup>b</sup>
Apple	6.20±1.81 <sup>a</sup>	7.50±1.10 <sup>a</sup>	7.30±1.45 <sup>a</sup>	5.80±2.03 <sup>b</sup>	6.97±1.57 <sup>a</sup>
Banana	6.28±1.79 <sup>a</sup>	5.72±1.90 <sup>b</sup>	5.16±2.02 <sup>b</sup>	6.19±1.98 <sup>b</sup>	7.11±1.42 <sup>a</sup>
Commercial sweet bread (standard)	7.22±1.35 <sup>a</sup>	6.66±1.69 <sup>ab</sup>	6.55±1.69 <sup>a</sup>	7.50±1.44 <sup>a</sup>	6.77±1.79 <sup>ab</sup>

Same superscript in same columns indicate that there is no significant difference between the results, for  $p \leq 0.05$

It was also evaluated the purchase intention, using the following scale:

- Would certainly not buy it
- Would probably not buy it
- Not sure if would buy it
- Would probably buy it
- Would certainly buy it

This study was approved by the Ethics Committee of Universidade Federal do Rio Grande do Sul (UFRGS), process number 20556.

The statistical analyses were made using the program ESTAT, version 2.0, with the Tukey's test, considering a 5% error probability. The results are given as means±standard deviation based on three measurements for each sample. There were considered as being statistically significant the results that had differences with  $p \leq 0.05$ .

## RESULTS

**Physical analysis:** The physical analysis showed that the raw and baked sample composed by the combination of common buckwheat flour and passion fruit flour was the heaviest ( $p \leq 0.05$ ), followed by the apple sweet bread loaf and the banana sweet bread loaf (Table 2).

The depth analysis of the raw samples suggests that the passion fruit flour sample also obtained more volume (3.06 cm), followed by the banana flour (2.63 cm) and the apple flour (2.50 cm) samples. However, no significant differences were found ( $p > 0.05$ ). The depth analyses of the baked products are as follows: passion fruit flour sample (4.53 cm) and apple flour sample (4.43 cm), without significant differences between them ( $p > 0.05$ ), but presenting a significant difference in relation to the banana flour sweet bread loaf (3.63 cm- $p \leq 0.05$ ).

The baking time also presented significant statistic difference: 72 min for the passion fruit flour sample, 64 min for the apple flour one and 60 min for the banana flour one, with an average of 65.3 min baking time.

**Chemical analysis:** The chemical analysis (Table 3) suggests that the passion fruit sample had a higher moisture percentage (46.57%), with statistically significant difference ( $p \leq 0.05$ ) in regard to the other samples. The banana sample indicated a higher ash percentage (1.08%), although without significant difference ( $p > 0.05$ ) when compared to the passion fruit sweet bread loaf. The fat test showed the banana sample as having the highest percentage of all (11.30%), with statistically significant difference in regard to the other samples ( $p \leq 0.05$ ), which did not have a significant difference among themselves ( $p > 0.05$ ). Proteins percentage indicated the standard sweet bread loaf as having the highest value (2.18%), with significant differences in regard to all the other samples ( $p \leq 0.05$ ).

Fibers (total, insoluble and soluble) were also evaluated. The highest amount was found in the passion fruit one, which total fiber (14.51%) overcomes more than two times apple sweet bread (5.8%). The commercial sample presented the lowest percentage (2.37%) and there were significant differences among each other ( $p \leq 0.05$ ). Insoluble fibers kept the ranking, with the passion fruit one showing 12.72%, followed by the apple one (5.1%), the banana sweet bread (4.49%) and the commercial sample (0.8%), again, all with significant differences ( $p \leq 0.05$ ). The passion fruit loaf and the commercial sample scored 1.79 and 1.57%, respectively, in soluble fiber. Both showed statistically significant differences ( $p \leq 0.05$ ).

**Sensory analysis:** The sensory analysis of the sweet bread samples showed a good acceptability rate of the ones made with common buckwheat flour and fruit

Table 5: Evaluator's purchase intention of gluten free and standard commercial sweet breads

Sweetbread samples	Purchase intention
Passion fruit	1.66+0.89 <sup>a</sup>
Apple	3.30+1.21 <sup>b</sup>
Banana	3.31+1.21 <sup>b</sup>
Commercial sweet bread (standard)	4.11+0.85 <sup>a</sup>

Same superscript in same columns indicate that there is no significant difference between the results, for  $p \leq 0.05$

flour (Table 4). Both apple and banana samples had good results in global acceptability (6.20 and 6.28, respectively, which means "like slightly", according to the hedonic scale), with no significant differences between them or even in comparison to the standard one, which still had the best result of all (7.22-like moderately).

The apple sweet bread was the one with the best score in terms of appearance (7.50-like moderately), with no significant differences ( $p > 0.05$ ) in relation to the standard commercial sample (6.66-like slightly). The color evaluation presented a good score for all samples, with no significant differences ( $p > 0.05$ ) among the samples with the exception of the banana one, which had the lowest result.

The standard commercial sweet bread had the best result in the taste assessment (7.5-like moderately), with significant differences ( $p \leq 0.05$ ) in relation to the other sweet bread loafs. The apple and banana samples had the following results: 5.80 (neither like nor dislike) and 6.19 (like slightly), respectively, with no significant differences ( $p > 0.05$ ) between them.

The results concerning texture indicated the banana sweet bread loaf as the best one (7.11-like moderately), but without significant differences ( $p > 0.05$ ) in relation to the apple sweet bread loaf (6.97-like slightly) and the standard sweet bread one (6.77-like slightly).

**Evaluator's purchase intention:** Table 5 presents the evaluator's purchase intention test, which indicated the standard commercial sweet bread as the most likely of being bought (4.11), with significant differences ( $p \leq 0.05$ ) in relation to the other sweet bread loafs, followed by the banana (3.31) and the apple samples (3.30).

## DISCUSSION

Sweet bread loafs made in this study presented lower growth rate when compared to the standard commercial one. Ács *et al.* (1996a, 1996b) studied the viability of using various binding agents, such as guar, xanthan, tragant and locust bean gum as substitute for gluten in gluten-free corn starch bread. These tests showed a significant increase in those products' loaf volume. It is possible that a gluten-free sweet bread formulation added of such binding agents could improve its growth rate. Bonafaccia and Kreft (1994)

also had similar results while experimenting bread formulations blended with increasing amounts of buckwheat flour. By the photographs showed in that study, it is clear that, as the percentage of buckwheat flour increases in the blending, the height gradually decreases, due to the decrease of the gluten matrix in the composition.

Moisture percentage was higher in all buckwheat sweet bread samples than in the standard one. This can be due to the higher water-binding feature of the buckwheat starch, which is superior to wheat (Wijngaard and Arendt, 2006). Also, Hager *et al.* (2012), in a study to investigate the quality, sensory and ultra structure characteristics of gluten-free bread, found that the moisture content was related to the amount of water added to the dough samples. This could be attributed to the extra milk volume added to the passion fruit sweet bread batter. On the other hand, moisture content is very important when regarding deterioration of baking quality, which is less in lower moisture percentage due to decrease in activity and respiration of microorganisms (Staudt and Zeigler, 1973). This could jeopardize the shelf life of the gluten-free sweet breads made in this study.

The gluten-free sweet bread loafs presented an increase in ash percentage in relation to the control sample. Bilgiçli (2008) also found an ash amount increase in buckwheat flour, corn starch and rice flour pasta formulations when compared to wheat flour control pasta. As the buckwheat flour amount increased from 40 to 60 g, so did the ash amount. Another study by Bonafaccia and Kreft (1994) also noticed higher ash percentage in 100% buckwheat flour pasta in comparison to 50% buckwheat flour+50% wheat flour pasta. Nevertheless, ash percentage could also be related to the fruit flours, as the apple sweet bread sample presented lower ash percentage than the standard commercial one.

Filipcëv *et al.* (2011) using increasing amounts of buckwheat to substitute wheat flour in 30, 40 and 50%, respectively in ginger nut biscuit, found higher rates in fat percentage, although with no significant difference ( $p > 0.05$ ). This could partially explain our findings in fat content being higher in gluten-free sweet bread samples than in the standard commercial one, as the first ones were made with whole milk. Jozinović *et al.* (2012) added different amounts of buckwheat flour to corn meal (ratio meal: flour = 70:30, 50:50 and 30:70), in order to determine its effects in extruded and non-extruded samples. There was an increase in fat percentage in non-extruded samples following buckwheat flour ratio.

Levels of protein were lower in all buckwheat flour sweet bread samples. Although wholegrain buckwheat flour contains higher protein percentage when compared to wheat flour (Bonafaccia *et al.*, 2003), it is also known that refined buckwheat flour has lower

protein content than refined wheat flour. Rayas-Duarte *et al.* (1996), while studying the quality of spaghetti containing buckwheat, amaranth and lupin flours mixed with durum flour, found that the higher the percentage of buckwheat, the lower the amount of protein the pasta would have. Unfortunately, there are few reports on the technological quality of buckwheat (Ikeda *et al.*, 1997).

It is already well known that dietary fiber plays an important role in reducing the risks of non-transmissible chronic diseases, such as cardiovascular diseases (Marlett, 2001). High percentage of fiber were also found by Chau and Huang (2003), in passion fruit seeds-which is used to produce the passion fruit flour used in one of the sweet breads-specifically insoluble fiber. In another study, apple fiber was compared to wheat and oat bran (Chen *et al.*, 1988). The total dietary fiber in apple was 61.9%, while wheat bran was 38.00%. Fruit flours usually have high levels of fiber. Although they were blended with buckwheat flour-which has significant more fiber than wheat flour (USDA, 2007), it is clear they help to improve the volume of fiber in one's diet.

Bilgiçli (2008), when studying the use of buckwheat flour in the production of gluten-free egg noodle, noticed that the color acceptability of the control sample was better than the buckwheat samples' one. That was not the case in this study, where the passion fruit and apple samples had the highest acceptability rates. This could be related to color changing due to the fruit flours, which caused a darker appearance to the sweet bread loafs. Nowadays, dark colored food tends to attract consumers' attention, since it is usually attributed to higher amounts of dietary fiber, as noticed by Chillo *et al.* (2008), when adding buckwheat flour and durum wheat bran to spaghetti.

Lin *et al.* (2009) reported that buckwheat improved wheat bread's color because it contains more phenolic compounds, which could inhibit the browning processes during baking.

Baljeet *et al.* (2010) also had low score in tasting evaluation of cookies incorporated with buckwheat. The authors suggest that this probably happened due to higher concentrations of rutin, which gives a bitter taste to buckwheat flour products. On the other hand, according to Chlopicka *et al.* (2012), sensory quality analysis of bread samples made with pseudo cereal flours (especially buckwheat) blended with wheat flour may increase acceptability attributes such as taste, color and odor. These observations suggest that the addition of buckwheat flour to bread can improve not only antioxidant but also sensory properties of bread.

Purchase intention suggests that the commercial standard sweet bread is more likely to be bought. However, there could be an assessment bias since the evaluators were all non-coeliac people and, therefore, could have considered a gluten product more to their liking. Nevertheless, the banana and apple sweet bread samples received a good purchase intention score. The passion fruit sample, on the other hand, received the

lowest score, which suggests that more research can be done to improve its acceptability.

## CONCLUSION

Changing wheat flour for common buckwheat flour demanded a few adaptations on products formula. Sweet bread formulations usually include candied fruit or fruit jelly, which made us consider adding fruit flour to the recipe a viable option. This also helped to give a different flavor to each sweet breads and made it possible for us to elaborate more than one recipe. The results were satisfactory, with good batter growth, good taste and overall acceptability. Although more research is necessary to improve these products, we believe that this gluten-free sweet bread loafs are viable products.

## ACKNOWLEDGMENT

The authors are thankful to FAPERGS, which financed this project, so it could be carried on.

## REFERENCES

- Ács, E., Z.S. Kovacs and J. Matuz, 1996a. Bread from corn starch for dietetic purposes I: Structure formation. *Cereal Res. Commun.*, 24: 441-449.
- Ács, E., Z.S. Kovacs and J. Matuz, 1996b. Bread from corn starch for dietetic purposes. II. Formation of the visual and technological properties. *Cereal Res. Commun.*, 24: 451-459.
- Baljeet, S.Y., B.Y. Ritika and L.Y. Roshan, 2010. Studies on functional properties and incorporation of buckwheat flour for biscuit making. *Int. Food Res. J.*, 17: 1067-1076.
- Bilgiçli, N., 2008. Utilization of buckwheat flour in gluten free egg noodle production. *J. Food Agric. Environ.*, 6: 113-115.
- Bonafaccia, G. and I. Kreft, 1994. Technological and qualitative characteristics of food products made with buckwheat. *Fagopyrum*, 14: 35-42.
- Bonafaccia, G., M. Marocchini and I. Kreft, 2003. Composition and technological properties of the flour and bran from common and tartary buckwheat. *Food Chem.*, 80: 9-15.
- Chau, C.F. and Y.L. Huang, 2004. Characterization of passion fruit seed fibers: A potential fiber source. *Food Chem.*, 85: 189-194.
- Chen, H., G.L. Rubenthaler, H.K. Leung and J.D. Baranowski, 1988. Chemical, physical and baking properties of apple fiber compared with wheat and oat bran. *Cereal Chem.*, 65: 244-247.
- Chillo, S., J. Laverse, P.M. Falcone, A.M. Protopapa and A. Del Nobile, 2008. Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality. *J. Cereal Sci.*, 47: 144-152.

- Chlopicka, J., P. Pasko, S. Gorinstein, A. Jedryas and P. Zagrodzki, 2012. Total phenolic and total flavonoid content, antioxidant activity and sensory evaluation of pseudocereal breads. *Food Sci. Technol.*, 46: 548-555.
- Filipčev, B., O. Šimurina, M. Sakac, I. Sedej, P. Jovanov, M. Pestoric and M. Bodroža-Solarov, 2011. Feasibility of use of buckwheat flour as an ingredient in ginger nut biscuit formulation. *Food Chem.*, 125: 164-170.
- Gallagher, E., T.R. Gormley and E.K. Arendt, 2004. Recent advances in the formulation of gluten-free cereal-based products. *Trends Food Sci. Tech.*, 15: 143-152.
- Hager, A.S., A. Wolter, M. Czerny, J. Bez, E. Zannini, E.K. Arendt and M. Czerny, 2012. Investigation of product quality, sensory profile and ultrastructure of breads made from a range of commercial gluten-free flours compared to their wheat counterparts. *Eur. Food Res. Technol.*, 235: 333-344.
- Ikeda, K., M. Kishida, I. Kreft and K. Yasumoto, 1997. Endogenous factors responsible for the textural characteristics of buckwheat products. *J. Nutr. Sci. Vitaminol.*, 43: 101-111.
- Jozinović, A., D. Šubarić, D. Ačkar, J. Babić, I. Klarić, M. Kopjar and K.V. Lendić, 2012. Influence of buckwheat and chestnut flour addition on properties of corn extrudates. *Croat. J. Food Sci. Technol.*, 4: 26-33.
- Kalinova, J. and E. Dadakova, 2009. Rutin and total quercetin content in amaranth (*Amaranthus* spp.). *Plant Foods Hum. Nutr.*, 64: 68-74.
- Kim, S.L., S.K. Kim and C.H. Park, 2004. Introduction and nutritional evaluation of buckwheat sprouts as a new vegetable. *Food Res. Int.*, 37: 319-327.
- Lin, L., H. Liu, Y. Yu, S. Lin and J. Mau, 2009. Quality and antioxidant property of buckwheat enhanced wheat bread. *Food Chem.*, 112: 987-991.
- Mahan, L.K. and S. Escott-Stump, 2004. *Krause's Food, Nutrition and Diet Therapy*. 11th Edn., WB Saunders, Philadelphia, PA.
- Manthey, F.A., S.R. Yalla, T.J. Dick and M. Badaruddin, 2004. Extrusion properties and cooking quality of spaghetti containing buckwheat bran flour. *Cereal Chem.*, 81(12): 232-236.
- Marlett, J.A., 2001. Dietary Fiber and Cardiovascular Disease. In: Cho, S.S. and M.L. Dreher (Eds.), *Handbook of Dietary Fiber*. Marcel Dekker, New York, pp: 17-30.
- Moore, M.M., M. Heinbockel, P. Dockery, H.M. Ulmer and E.K. Arendt, 2006. Network formation in gluten-free bread with application of transglutaminase. *Cereal Chem.*, 83: 28-36.
- Rayas-Duarte, C.M., C.M. Mock and L.D. Satterlee, 1996. Quality of spaghetti containing buckwheat, amaranth and lupin flours. *Cereal Chem.*, 73: 381-387.
- Silva, D.B.D., A.F. Guerra, A.C. Da Silva and J.S.R. Póvoa, 2002. Evaluation of genotypes of buckwheat in the Cerrado region. *Embrapa Genetic Resources and Biotechnology. Newsletter of Research and Development*, 21. Embrapa Genetic Resources and Biotechnology, Brasília, (In Portuguese).
- Staudt, E. and S.E. Ziegler, 1973. *Flour Chemistry*. 1st Edn., Bhullar Brothers Ltd., Engineering Works 9240 Uzwil, Switzerland.
- USDA, 2007. Software USDA Food Search for Windows. Version 1.0, Database Version: SR16.
- Wieser, H., 2007. Chemistry of gluten proteins. *Food Microbiol.*, 24: 115-119.
- Wijngaard, H.H. and E.K. Arendt, 2006. Buckwheat. *Cereal Chem.*, 83(4): 391-401.
- Wojcicki, J., B. Barcew-Wiszniowska, L. Samochowiec and L. Rozewicka, 1995. Extractum fagopyri reduces arteriosclerosis in high-fat diet fed rabbits. *Pharmazie*, 50: 560-562.
- Yang, J., J. Guo and J. Yuan, 2008. In vitro antioxidant properties of rutin. *LWT-Food Sci. Technol.*, 41: 1060-1066.