VOL. 7, NO. 8, AUGUST 2012 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science


www.arpnjournals.com

PREPARATION AND EVALUATION OF GLUTEN FREE READY TO SERVE BUCKWHEAT PRODUCT

Faizullah Khan, Alam Zeb, Muhammad Arif, Javid Ullah and Said Wahab
Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan
Council of Scientific and Industrial Research Laboratories Complex, Peshawar, Pakistan
E-Mail: faizkarinasbt@gmail.com

ABSTRACT

The present study pertains to the development of a gluten free ready to serve buckwheat nutritious powdered product. The process consists of dehulling and extrusion of dehulled buckwheat from which ready to serve buckwheat flour is obtained. The ready to serve flour is further utilized for product development by mixing it with skimmed milk powder, sugar and food grade additives. The developed product has excellent palatability, agreeable odor and flavor. The developed product is highly nutritious, energizing and refreshing. The gluten free character makes it a perfect nutritional supplement for gluten allergic and other celiac patients as well as for those who have difficulty in mastication swallowing and digestion. The product is dissolvable in hot and cold both water and milk.

Keywords: buckwheat, gluten free, proximate, mineral composition, ready to serve, extrusion.

INTRODUCTION

Buckwheat (*Fagopyrum esculentum*) belongs to the Polygonaceae family, is usually considered a cereal in agriculture and food technology because of its usage and the cultivation techniques used. Originating from Asia and introduced into Europe around the 15th century, the cultivation of buckwheat has spread to Canada, the United States of America and to certain areas of Africa and Latin America, with an annual yield, worldwide, of approximately one million tons. The agricultural features which have first and foremost encouraged its cultivation in such varied regions are primarily that buckwheat is semi-wild, does not have particular soil or fertilization requirements and can, furthermore, grow at high altitudes above 3,000 meters in Nepal and Bhutan.

In comparison with traditional cereals, buckwheat proteins are high in lysine, which makes it interesting from a nutritional point of view and also gluten free. It could therefore be used as a substitute for wheat in gluten-free diets for celiac patients (Eggum *et al*., 1980; Javornik *et al*., 1984). Buckwheat flour contains some essential nutrients at a high level. Therefore, buckwheat can be a potential source of such essential nutrients. In view of its beneficial effects on human health (Sugiyama *et al*., 2003) increasing attention to buckwheat as a functional food has been currently paid. It is considered that buckwheat flour and its products can be totally a food with high nutritional value (Mazza *et al*., 1998).

Buckwheat products are important source of trace elements and dietary fiber. Buckwheat proteins have a high biological value. Buckwheat protein products have been associated with preventive nutrition. Buckwheat has no gluten, so it is safe for patients with celiac disease. Buckwheat may be a valuable source of minerals for the people who consume it. It is a good source of dietary zinc, copper, and manganese (Ikeda *et al*., 1993).

The aim of the present work is involved in preparation and formulation of value added products from natural resources of the country.

MATERIALS AND METHOD

The present research work was carried out in Pakistan Council of Scientific and Industrial Research (PCSIR) Laboratories Complex, Jamrud Road, Peshawar. Common Buckwheat (*Fagopyrum esculentum*) was obtained from Skardu Baltistan. The sample was thoroughly cleaned to remove stones and dust.

Dehulling of buckwheat

Hulls were removed by passing dehulling machine. The hulls removed through blower/aspirator and dehulled buckwheat obtained.

Milling of buckwheat

The grains were milled by using laboratory mill 3100 Finland. The flour sealed in polyethylene bags and stored in refrigerator for further use.

Extrusion of buckwheat flour

The buckwheat flour was extruded using signal screw extruder (S# 1889, M.2160, USA). The main purpose of extrusion of buckwheat flour was cooking of starch to develop ready to serve flour. The dehulled buckwheat was tempered to 40% moisture level and allowed to stand for four hours at room temperature. The tempered buckwheat passes through extruder at 180°C. The extruded puffed material was obtained for development of ready to serve product.

Grinding of extruded material

The extruded puffed material passed through pin grinder (M # B-14, England) and ready to serve buckwheat flour obtained. The developed flour passed through sieve of 30- mesh size and further used for the development of product with other ingredients.

Proximate composition

Proximate composition includes moisture, crude protein, ether extract, crude fiber, ash, and nitrogen free

extract. Moisture was determined by oven dehydration method at 105°C up to the constant weight. Crude protein was determined by using Kjeldhal method; crude fat was determined by ether extraction method using soxhlet apparatus. Crude fiber was determined by acid digestion and alkali digestion method. Ash content was determined in muffle furnace at 550°C for 6 hours. For all these determinations powdered and oven dried sample were used in triplicate in accordance with standard procedures. NFE was calculated by difference (AOAC 2000).

Determination of minerals

For minerals determination 0.5g of each sample was wet digested with HNO_3: $HClO_4$ (2:1) for 2-3 hrs on heating mantle [29]. Digested samples were filtered through 0.45 µm pore size Millipore filter and volume was made to 100 ml with distilled water. Concentration of Ca, Mg, Fe, Cu, Mn, and Zn was determined on Hitachi Zeeman Japan Z-8000, Atomic Absorption Spectrophotometer equipped with standard hallow cathode lamps as radiation source using air acetylene flames. The instrument setting and operations were done in accordance with the manufacturer user's specification. Sodium and calcium was determined by flame photometer using the recommended method of AOAC (2000).

The sample solutions were appropriately diluted, if required, prior to direct measurements and calibration curves were obtained for micro and macro minerals using standard solutions. They were linear and correlation coefficient of each curve was above 0.9900, which indicated a best fit between concentration of the standard solutions and respective absorbance values. Accuracy, precision of the method was verified by standard addition/recovery method [28]. Analysis of each element was carried out in triplicate and standard deviation was calculated. For background correction, blank was analyzed under instrumental conditions. The concentration of minerals was recorded in ppm which was then converted into mg/100g on dry weight basis. (Niazi *et al*., 1997).

Mixing of additives

Sugar, and skim milk was weighed using toploding weighing machine and minor additives were weighed using electronic balance (GmbH-2842, Germany) Calculated amount of anti caking agent Di-calcium phosphate and Preservative potassium meta-bi-sulphite were weighed using electronic balance and added in pan. The material mixed thoroughly.

Dehydration

The material was then kept in dehydrator at 70°C for three hours to remove atmospheric moisture. After dehydration product was filled in polyethylene bags and sealed.

RESULTS AND DISCUSSIONS

For the preparation of gluten free ready to serve product, an optimal recipe was explored and required ingredients were considered carefully. Several ingredients i.e., extruded buckwheat flour, sugar, skim milk powder, and other food grade additives were selected for the study. These ingredients were selected after conducting exploratory and subsidiary trials. Sensory evaluations were employed during above trials using nine point hedonic scale (Larmond, E., 1977).

The sensory evaluation of the product was carried to check its solubility, color, taste, and overall acceptability as shown in Table-2. On the basis of organoleptic/sensory evaluation of the prepared products, the drink prepared from treatment T4 (i.e., 40% buckwheat extruded flour 40% skim milk 20% sugar malt with addition of food grade additives) was liked very much and got highest score as compared to other treatment developed products. The final products were further analyzed chemically in order to check its suitability for nutritional purpose.

Table-1 depicts the % extruded buckwheat flour, skim milk, sugar, and g/kg of anti caking agent and preservative tried for development of gluten free ready to serve products acceptable. Treatment T4 (buckwheat extruded flour 40% skim milk 40% and sugar 20%) was found suitable in terms of sensory properties.

Extruded buckwheat flour 40% shows acceptable in taste, color, solubility and overall acceptability. Extrusion of buckwheat increases palatability and solubility of buckwheat in water and milk in both cold and hot conditions.

Table-3 depicts the proximate composition of the different treatments developed products. Treatment T4 was liked very much and found highest score of sensory evaluation. The proximate composition of developed T4 product i.e., moisture, crude protein, crude fat, crude fiber, ash, carbohydrate content and gluten content observed was 4.72 ± 0.02 %, 15.34 ± 0.03 %, 0.34 ± 0.11 %, 0.07 ± 0.41 %, 2.63 ± 0.08 % 76.90 ± 0.03 % and gluten was not detected, respectively.

Table-4 depicts the mineral composition of the different treatments developed products. Treatment T4 was liked very much and found highest score of sensory evaluation. The mineral composition of developed T4 product i.e., selected micro (Fe, Zn and Mn) and macro (K, Na and Ca) minerals were determined and their concentration have been reported as milligram per hundred gram (mg / 100 g) on dry weight basis as shown in Table-4.

In gluten free ready to serve powdered product, among the micro minerals the amount of Fe (8.28± 0.3) and Zn (3.77± 0.02) was maximum while Mn (0.36± 0.01) was lowest. In the macro minerals, the amount of K (392.33± 0.3) was maximum while Na (300.23± 0.23) was in moderate amount and Ca (193.4± 0.2) was the lowest.

Table-1. Experiment design of gluten free ready to serve product.

Treatment	Buckwheat (extruded flour)	Skim milk	Sugar	Anti-caking agent g/kg	Preservative g/kg
T_0 (control)	80%		20%	2g	0.5g
T_1	70%	10%	20%	2g	0.5g
T_2	60%	20%	20%	2g	0.5g
T_3	50%	30%	20%	2g	0.5g
T_4	40%	40%	20%	2g	0.5g
T_5	30%	50%	20%	2g	0.5g

Table-2. Sensory/Organoleptic evaluation of different treatments of gluten free ready to serve product (9-Point hedonic scale).

Treatments	Solubility	Color	Taste	Overall acceptability
To	5.40± 0.82	6.00±0.62	6.4±0.82	5.8±0.74
T1	6.3± 0.90	6.61±1.0	6.9±1.31	6.4±0.45
T2	6.8± 1.0	6.9±1.32	7.6±0.43	6.9±1.25
T3	7.2± 0.8	6.93±1.42	7.9±1.5	7.5±1.6
T4	7.4± 0.75	7.3±0.92	8.6±0.81	8.4±0.68
T5	7.6± 0.92	7.2±1.24	6.7±1.83	6.58±0.56

Average of triplicate determinations ± SD (standard deviation)

Table-3. Proximate composition of different treatments of gluten free ready to serve product. (%).

Treatments	Moisture	Crude protein	Crude fat	Crude fiber	Ash	N.F.E	Gluten
To	7.30±0.02	12.56±0.03	1.01±0.07	0.70±0.47	0.66±0.08	77.76±0.03	N.D
T1	6.86±0.01	13.06±0.03	0.71±0.05	0.53±0.01	0.91±0.04	77.91±0.03	N.D
T2	6.06±0.05	13.80±0.02	0.59±0.02	0.36±0.03	1.41±0.04	77.77±0.27	N.D
T3	5.40±0.07	14.30±0.07	0.46±0.03	0.18±0.03	2.01±0.03	77.65±0.04	N.D
T4	4.72±0.02	15.34±0.03	0.34±0.11	0.07±0.41	2.63±0.08	76.90±0.03	N.D
T5	4.00±0.08	15.99±0.13	0.21±0.05	0.00±0.00	3.27±0.40	76.17±1.03	N.D
C.V (%)	2.54	1.36	7.81	9.32	1.43	0.30	--

Average of triplicate determinations ± SD (standard deviation)

Table-4. Mineral composition of different treatments of gluten free ready to serve product. (mg/100g).

Treatments	Potassium (K)	Sodium (Na)	Calcium (Ca)	Iron (Fe)	Manganese (Mn)	Zinc (Zn)
To	231.7±0.15	76.4±0.01	23.9±.003	17.02±0.01	1.00±0.02	2.82±0.02
T1	279.7±0.15	133.8±0.26	67.7±0.02	15.77±0.04	0.90±0.01	3.45±0.03
T2	311.3±0.21	189.5±0.12	107.53±0.11	13.22±0.04	0.72±0.01	3.56±0.1
T3	351.4±0.4	238.9±0.03	150.7±0.02	11.21±0.01	0.54±0.01	3.67±0.02
T4	392.33±0.3	300.23±0.23	193.4±0.2	8.28±0.3	0.36±0.01	3.77±0.02
T5	402.8±0.4	319.87±0.07	228.23±0.09	5.77±0.01	0.21±0.01	3.54±0.02
C.V (%)	1.49	10.94	2.21	7.75	11.50	6.64

Average of triplicate determinations ± SD (standard deviation)

There are some micronutrients, which are essential for human health and occur in the body in microgram range. Elements like iron, zinc, copper, manganese, chromium, cobalt and selenium play an important role in the health of individuals; in fact their role is as important as that of vitamins. They function as cofactors for many enzymes. It is essential to maintain the required level of trace elements in the human body (Baptist *et al*., 1999).

Sodium and potassium are the major ions in the body fluids. The regulation of proper concentration of these ions in the extra cellular and intra cellular fluid is critical for homeostasis (Montgomery *et al*., 1999). Calcium is essential for the clotting of blood, the action of certain enzymes and the control of the passage of fluids through the cell walls (Mike. *et al*., 1999). Iron has the longest and best described history among all the micronutrients. It is a key element in the metabolism of almost all living organisms. In humans, iron is an essential component of hundreds of proteins and enzymes (Fairbanks. *et al*., 1999.)

Copper (Cu) is an essential trace element for humans and animals. In the body, copper shifts between the cuprous (Cu^{1+}) and the cupric (Cu^{2+}) forms, though the majority of the body's copper is in the Cu^{2+} form. The ability of copper to easily accept and donate electrons explain its important role in oxidation-reduction (redox) reactions and the scavenging of free radicals(Linder. *et al*., 1996). Manganese (Mn) plays an important role in a number of physiologic processes as a constituent of some enzymes and an activator of other enzymes (Nielsen *et al*., 1999). Zinc plays an important role in the structure of proteins and cell membranes. A finger-like structure, known as a zinc finger motif, stabilizes the structure of a number of proteins. For example, copper provides the catalytic activity for the antioxidant enzyme copper-zinc superoxide dismutase (Cu Zn SOD), while zinc plays a critical structural role (Food and Nutrition Board, 2001). The structure and function of cell membranes are also affected by zinc. Loss of zinc from biological membranes increases their susceptibility to oxidative damage and impairs their function (Dell *et al*., 2000).

CONCLUSIONS

The results of the present research revealed that gluten free ready to serve product of buckwheat was found acceptable with skim milk and sugar.

Treatment T4 (buckwheat flour 40% skim milk powder 40% and sugar 20%) was found suitable in term of physicochemical and sensory properties.

The product was found gluten free and recommended for consumers who are gluten allergic (celiac diseases) or having difficulty in mastication and swallowing of foods.

Extrusion increase solubility and palatability of buckwheat.

REFERENCES

Eggum B. O, Kreft I and Javornik B. 1980. Chemical composition and protein quality of buckwheat (*Fagopyrum esculentum* Moench). Plant Foods for Human Nutrition. 30(3-4): 175-179.

Javornik B. and Kreft I. 1984. Characterization of buckwheat proteins. Fagopyrum. 4: 30-38.

Jenkins D.J.A., Wolever T.M.S, Taylor R.H., Barker H., Fielden H., Baldwin J.M., Bowling A.C., Newman H.C., Jenkinsand A.L. and Goff D.V. 1981. Glycemic index of foods: a physiological basis for carbohydrate exchange. Am. J. Clin. Nutr. 34: 362-366.

Foster-Powell K. and Miller I.B. 1995. International tables of glycemic index. Am. J. Clin. Nutr. 62: 871S-890 S.

Sugiyama M., Tang A.C. Wakaki Y. and Koyama W. 2003. Glycemic index of single and mixed meal foods among common Japanese foods with white rice as a reference food. Eur. J. Clin. Nutr. 57: 743-752.

Bonafaccia G and Kreft I. 1998. Possibilities for the development of new products from minor cereals. In: H. Corke and R. Lin (Eds.). Asian Food Product Development. Science Press, Beijing, China. pp. 1-5.

Mazza G. 1998. Functional foods. Technomic Publishing Co., Inc., Lancaster, Pennsylvania.

Ikeda S. and Yamashita Y. 1994. Buckwheat as a dietary source of zinc, copper and manganese. Fagopyrum. 14: 29-34.

Steadman K. J., Burgoon M. S., Lewis B. A., Edwardson S. E. and Obendorf R. L. 2001. Minerals, phytic acid, tannin and rutin in buckwheat seed milling fractions. Journal of the Science of Food and Agriculture. 81: 1094-1100.

Skrabanja V., Nygaard L. H. and Kreft I. 2000. Protein-polyphenol interactions and in vivo digestibility of buckwheat groat proteins. Pflügers Archiv. 440: R129-R131.

Liu Z., Ishikawa W., Huang X., Tomotake H., Kayashita J., Watanabe H., Nakajoh M. and Kato N. A. 2001. Buckwheat protein product suppresses 1, 2-dimethylhydrazine-inducedcolon carcinogenesis in rats by reducing cell proliferation. The Journal of Nutrition. 131: 1850-1853.

Skerrit J. H. 1986. Molecular comparison of alcohol-soluble wheat and buckwheat proteins. Cereal Chemistry. 63: 365-369.

Ikeda S. and Yamaguchi Y. 1993. Zinc contents in various samples and products of buckwheat. Fagopyrum. 13: 11-14.

Amarowicz R. and Fornal L. 1987. Characteristics of buckwheat grain mineral components and dietary fiber. Fagopyrum. 7: 3-6.

Larmond E. 1977. Laboratory Methods for Sensory Evaluation of Foods., Department of Agri.Canada. Pub. No. 1637. Ottawa, Canada.
Starvation. The Merck Manual, Section 1, Chapter 2, Malnutrition. Accessed at http://www.merck.com/mrkshared/mmanual/section1/chapter2/2b.jsp 9/13/2006.

Harrison's. 1994. Principles of Internal Medicine. Issebbecker, Braunwald, Wilson, Martin, Fanci and Kaspe (Eds.). McGraw-Hill, Inc.

Baylor College of medicine (BCM) Gastroenterology Grand Rounds. Metabolic deficiencies in chronic pancreatitis. Accessed at http://www.bcm.edu/gastro/DDC/grandrounds/BCM/8-5-04/09 DISC.HTM 10/18/2006.

M. Baptist, M. Azim, M. Khan and K.M. Janjua. 1999. Pakistan Journal of Medical Research. 32: 263.

R. Montgomery, T.W. Conway, A.A. Specter and D. Chappell. 1999. Nutrition. In: Biochemistry. Osby-year book Inc., 6th edition, USA. p. 120.

B. Mike. 1999. The role of minerals in human nutrition. Life Sciences Courses.

L. Beard and H.D. Dawson, Iron. 1997. Handbook of nutritionally essential minerals. In: B.L O'Dell R.A. Sunde (Eds.). New York, Marcel Dekker, Inc. p. 275.

F. Fairbanks. 1999. Iron in Medicine and Nutrition. In: M. Shils, J.A. Olson, M. Shike, A.C. Ross, (Eds.). Nutrition in Health and Disease. 9th Ed. Baltimore: Williams and Wilkins. p. 223.

M.C. Linder and M. Hazegh-Azam. 1996. Copper biochemistry and molecular biology. The American Journal of Clinical Nutrition. 63: 797.

F.H Nielsen. 1999. Ultra trace minerals. In: M Shils, J.A. Olson, M. Shike, A.C. Ross, (eds.). Nutrition in Health and Disease. 9th Ed. Baltimore: Williams and Wilkins. p. 283.

2001. Food and Nutrition Board, Institute of Medicine. Dietary reference intakes for vitamin A, vitamin K, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc, National Academy Press, Washington D.C, USA.

B.L O'Dell. 2000. Role of zinc in plasma membrane function. Journal of Nutrition. 130: 1432.

F.B Niazi, F. Mahmood and M.Z. Asghar. 1997. Journal of the Chemical Society of Pakistan. 19: 122.

AOAC. 1984. Official Methods of Analysis. 14th Ed. Sidney Williams. Association of Official Chemists, Inc. Virginia, USA.

A.O.A.C. 2000. Official methods of analysis (by Dr.William Horwitz). 17th Ed. Association of Official and Analytical Chemistry, Gaithersburg, MD, USA.