Research Article Open Access

Quality Assessment of Doughnuts Prepared by Using Small Sized Potatoes (Diamant)

Anique Dawood, Sarfraz Hussain*, Muhammad Nadeem, Saqib Jabbar, Tahir Mahmood Qureshi, Muhammad Umar Nasir, Syeda Mahvish Zahra, Farhat Rashid

Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan

Article History
Received
March 24, 2015

Published Online
June 16, 2015

Keywords:
Food security
Potatoes doughnut,
Physico-chemical characteristics,
Proximate analysis,
Sensory properties

Abstract: The main purpose of this project was to use small sized potatoes in the preparation of doughnuts, which are annually wasted in large amounts. In the present study, small sized potatoes were utilized in the preparation of doughnuts. The amounts of flour, egg, oil and baking powder were kept constant by varying the amounts of potatoes and sugar in doughnuts recipe. Control treatment (T_0) of potato based doughnuts was prepared without 0% potatoes. Whereas treatments T_1 was prepared with 30% potatoes, T_2 with 40% potatoes, and T_3 with 50% potatoes. Potatoes were subjected to sorting, washing, boiling, peeling and mashing, followed by mixing with doughnut batter. The results showed that doughnuts contained moisture (74.62-79.62%), protein (4.95-7.77%), fat (6.02-13.02%), fiber (0.34-0.56%) and ash (2.12-3.38%). The treatment T_3 had low moisture, crude protein and crude fat contents than T_1 and T_2, but it contained high crude fiber and crude ash contents than T_1 and T_2. All the treatments were observed to be acceptable, but T_3 was liked more among all treatments during sensory evaluation. In this way wastage of small sized potatoes can be prevented to and utilized to nourish food deprived population. This technique will be helpful to alleviate food security issues of local population.

***Corresponding authors:** Dr. Sarfraz Hussain sarfrazuaf2002@yahoo.co.uk

Cite this article as: Dawood, A., S. Hussain, M. Nadeem, S. Jabbar, T.M. Qureshi, M.U. Nasir, S.M. Zahra and F. Rashid. 2015. **Quality assessment of Doughnut prepared by using small sized potatoes (Diamant).** *Journal of Environmental & Agricultural Sciences*. 4:21-27.

1. Introduction

Potato (*Solanum tuberosum*) is one of the most important crops of the Solanaceae family (Xu et al., 2011). Due to its good nutritional and economic significance, potato is well known throughout the world by different classes of people. (Philips and Rix, 1993; Lachman and Hamouz, 2005; Low et al., 2007).

Potato is a very important crop worldwide. It is most unique and most potential crop in whole world because of its high productivity rate and it is fulfilling major food requirements of the world. It contains high amounts of carbohydrates, phosphorous, calcium, vitamin C, β-carotene After wheat, rice and maize, potato is a fourth number among the world's most important food crops (Marwaha, 1999; Reyes et al., 2005; Rumbaoa et al., 2009).

Processing of potato is very old and was practiced efficiently in ancient times in highland areas of Peru and Bolivia. Potatoes were processed into freeze drying and drying naturally in ancient times. They were processed into "chuno" and "papa seca" the naturally freeze dried and dried forms of potatoes. Potato served as a primary food source for several centuries in Peru. People used to preserve large amounts of potatoes during the excessive production period to consume them during the famine period (Woolfe and Poats, 1987). The minimal processing technique can be defined as a method of preparation of easy to use convenient fresh food products which can be used straight away with convenience in less time. Minimal processing has two objectives. First is to keep the product fresh and to retain its nutritional value. Second is to increase the shelf life of products and made the product acceptable for consumers. Processes like washing, sorting, trimming, peeling, slicing or chopping, blanching etc. are considered as minimal or lightly processing, these minimal processed practices enhance the freshness of vegetables to a great extent (Kaur and Kapoor, 2000; Cliffe-Byrnes et al., 2007).

The basic aim of this project was to utilize small sized potatoes, which can't be utilized by potato processing industry to produce snack products as chips, cutlets, fresh fries and puffed products. In Pakistan every year a large amount of small sized potatoes are wasted due to the reason that they are separated out during sorting and grading and considered unfit for processing by the industry and not relished by the consumers. So this project was focused on transformation of these small sized potatoes into doughnuts which is a valuable food product.

In view of the above scenario, this project was designed to determine suitability of doughnut preparation from small sized potatoes and to evaluate

and analyze chemical, physical and sensory attributes of potato doughnuts.

2. Materials and Methods

2.1 Preparation of potato mash

Fresh small sized potatoes (*Solanum tuberosum*) of variety (Diamant) were purchased from the local market of Sargodha, Punjab, Pakistan. Firstly, during sorting, undesired and blemished potatoes were separated from the bulk. Then proper washing of potatoes was done and adhering soil particles and contaminants were removed with tap water. After washing potato tubers (1 kg) were put in the boiling water (100 ℃) for 15 minutes. Peels of the boiled potatoes were manually removed. Peeled potatoes were properly mashed using hands. The preparation of potato mash was done in laminar air flow to prevent contamination. The process flow diagram is shown in Fig. 1.

2.2. Preparation of doughnut batter

The recipe of Anonymous (2001) was used for the preparation of doughnuts with slight modifications. The formulation of different treatments for the preparation of doughnuts is given in Table 1. First of all batter of doughnuts was prepared by mixing sugar with eggs and beaten till foaming and then margarine was added in it. Then, the flour, salt, mashed potatoes and baking powder were added and the batter was prepared by adding milk. After proper mixing, the batter of doughnuts was given a proper shape of doughnuts (1/4 inch width) by a doughnut mould. Then proofing of moulded doughnuts was allowed for 15 minutes at room temperature for raising the volume of the doughnuts. The proofed doughnuts were fried in a fryer at 180 ºC in canola oil for 3 minutes. The fried doughnuts were allowed to cool at room temperature for 15 minutes and packed in low density polyethylene bags (4" wide × 6" long), after removing maximum air by manually pressing, for further studies and evaluation.

2.3. Physico-chemical analysis

2.3.1. Determination of the density

Density was determined by the formula of density, i.e. (mass/unit volume). In this method the sample of potatoes was randomly chosen. Potatoes were weighed on weighing balance (weight in air). Water was taken in a graduated cylinder and its level was noted. Then samples of potato were inserted in a graduated cylinder and increase in volume of water was noted. The volume of potatoes was calculated to be the change in volume of water. The density of the potatoes was calculated by following equation

Density = Weight in air/unit volume [1]

2.3.2. Determination of chemical composition

The moisture, protein, fat, fiber and crude ash contents of the samples were determined by the method given in AOAC, (2000).

2.4. Sensory evaluation

Sensory evaluation has been defined as "a scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of foods and materials as they are recognized by the senses of sight, smell, touch and hearing (Andani, 2000). Sensory evaluations of potatoes were carried out by making doughnuts as follows: Samples were rated by a panel of 20 judges following the 9 points Hedonic Scale (Larmond, 1977; Abid et al., 2014; Haque et al., 2015). The parameters color, texture, flavor, crispiness and overall acceptability were studied during sensory evaluation.

2.5. Statistical analysis

The results were analyzed to statistical analysis by using Analysis of Variance Technique (One Way-ANOVA). Level of significance within mean was measured by using the complete randomize design Test. Significant differences between mean values were determined by LSD at a significance level of $p < 0.05$. Statistix 9.0 software (Analytical Software, Tallahassee FL, USA) was used for statistical analyses. Principal component analysis (PCA) was used to analyze the correlation between doughnut samples and quality parameters by using Minitab statistical software (Version 16.0, Minitab Inc., Enterprise Drive State College, PA).

Table 1: Formulation of different treatments

Treatments	Mashed potato	Flour	Sugar	Egg	Oil	Baking powder
T_0	0 g	240 g	120 g	58 g	30 mL	8.38 g
T_1	100g	240 g	170 g	58 g	30 mL	8.38 g
T_2	160 g	240 g	200 g	58 g	30 mL	8.38 g
T_3	240 g	240 g	240 g	58 g	30 mL	8.38 g

T_0 = Sample without potato, T_1 = Sample with 30% potato, T_2 = Sample with 40% potato, T_3 = Sample with 50 % potato

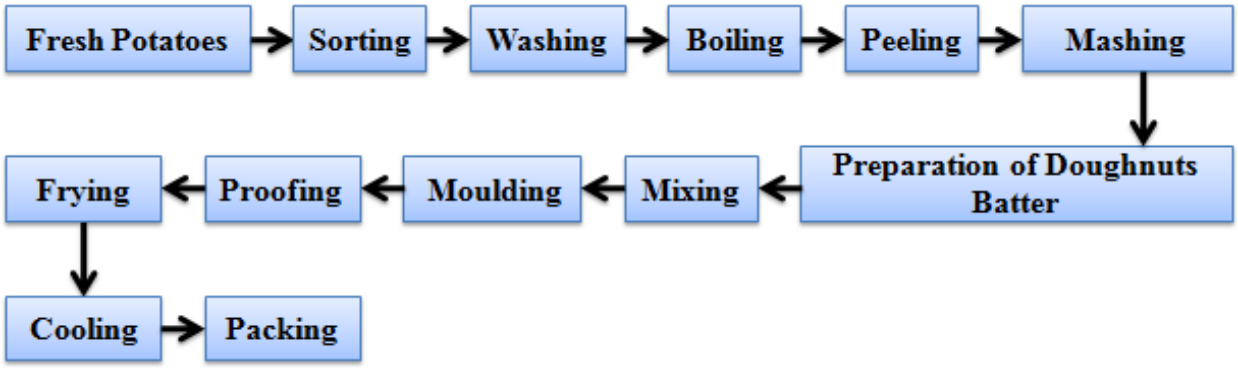

Figure 1. Flow sheet of potato doughnuts preparation.

3. Results and discussion

3.1 Physico-chemical analysis of fresh potatoes

The density of small sized potatoes was found to be 0.98. Sapers and Miller, (1993) explained density of fresh potatoes 0.97 and Shah et al. (2003) explained density of fresh potatoes 0.98. Malik, (1995) stated that density, total solids and starch contents were closely related because of a fact that a basic portion of dry matter and percentage of non-starch solids in fresh potatoes are relatively constant. Density, amount of dry matter content in potatoes and yield of product from potatoes, all these were directly proportional to each other. It's mean, if the specific density of potatoes was greater, then there was the large amount of dry matter in those potatoes and there was a tremendous yield of product from such potatoes. So potato cultivars with high specific gravity were recommended for manufacturing of potato based doughnuts, chips, fresh fries and dehydrated products. Whereas potato cultivars having low specific gravity were recommended for canning. The results regarding physico-chemical analysis are shown in Figure 2.

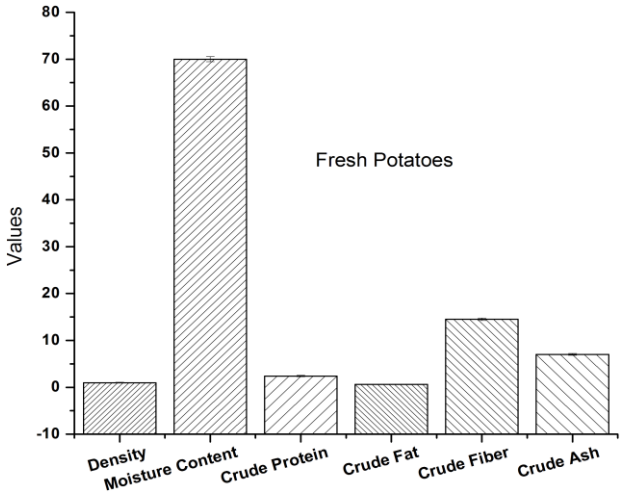

Figure 2. Physio-chemical analysis of fresh potatoes.

The moisture contents of the fresh potatoes were 70 %, which are in accordance with the previous studies (Abid, 1998; Johnson and Peterson, 1974; Luh et al., 1975). The crude protein contents were 2.4 %, and the previous studies show the same results (Johnson and Peterson, 1974; Temple et al., 1991). The crude fat contents were 0.6 %, and similar results were observed by the previous scientists (Abid, 1998; Johnson and Peterson, 1974). And the crude fiber and crude ash contents of fresh potatoes were 14.5% and 7% respectively.

3.2. Effect of different treatments on the physico-chemical properties of doughnuts.

The effects of different treatments on physico-chemical analysis of doughnuts are shown in Figure 3. The maximum value of moisture contents was observed in treatment T_0 (80.82 ± 0.34%) while the minimum value of moisture contents was noted in treatment T_3 (74.62 ± 0.41%). The moisture contents in treatments T_1 and T_2 were 79.62 ± 0.24% and 77.41 ± 0.44% respectively. The results showed that treatment T_0 (without potatoes) had the highest moisture contents due to which chances of rancidity were highest in treatment T_0. Moreover, due to high amounts of moisture, the treatment T_0 also lost its crispiness. Whereas treatment T_3 (50% potatoes) had the lowest moisture contents and due to low moisture contents the treatment had improved texture and crispiness. Because of low moisture contents chances of rancidity due to microbial and fungal activity were also very low in treatment T_3. Our results are in accordance with the Haque et al. (2015). They reported that development of food products with low moisture contents is important to achieve increased shelf life.

The results regarding to crude protein contents of doughnuts are presented in Figure 3. The highest protein contents were observed in treatment T_0 (9.23 ± 0.13%). Whereas treatment T_3 (4.95 ± 0.06%)

showed the lowest protein contents. The crude protein contents in treatments T_1 and T_2 were 7.77 ± 0.11% and 7.26 ± 0.10% respectively. Our results are in line with the previous results (Rehman et al., 2007).

The results regarding to crude fat contents of doughnuts are shown in Figure 3. The highest percentage of crude fat contents was observed in treatment T_0 (15.02 ± 0.19%). Whereas treatment T_3 (6.02 ± 0.13%) showed the lowest percentage of crude fat contents. The crude fat contents in treatments T_1 and T_2 were 13.02 ± 0.15% and 10.53 ± 0.19% respectively. Usually due to fat sensory attributes are adversely affected in doughnuts (Lee et al., 2008).

The results regarding to crude fiber contents of doughnuts are presented in Figure 3. The lowest value of crude fiber contents was observed in treatment T_0 (0.51 ± 0.02%). Whereas treatment T_3 (0.56 ± 0.03%) showed the highest value of crude fiber contents. The high amount of dietary fiber in a food product indicates that that product is good against the prevention of cardiovascular diseases as well as it imparts good impact of bowel movement. The crude fiber contents in treatments T_1 and T_2 were 0.34 ± 0.01% and 0.42 ± 0.14% respectively. Our results are in accordance with the Haque et al. (2015). They reported that dietary fiber increases the nutritional value of the baked products, but at the same time it usually alters the rheological properties of the dough and thus changes the quality and sensory properties of the baked products.

The results regarding to crude ash contents of doughnuts are presented in Figure 3. The lowest amount of crude ash contents was observed in treatment T_0 (1.02 ± 0.04%) whereas, the highest amount of crude ash contents was observed in treatment T_3 (3.38 ± 0.06%). While the crude ash contents in treatments T_1 and T_2 were 2.12 ± 0.11% and 2.93 ± 0.10% respectively.

3.3. Effect of different treatments on the sensory properties of doughnuts

The results regarding sensory evaluation of doughnuts are presented in Figure 4. The lowest score for color was observed in treatment T_0 (3.8 ± 0.06) whereas, the highest score was observed in treatment T_3 (8.2 ± 0.10). While the sensory score of treatments T_1 and T_2 were 4.5 ± 0.03 and 5.4 ± 0.07 respectively.

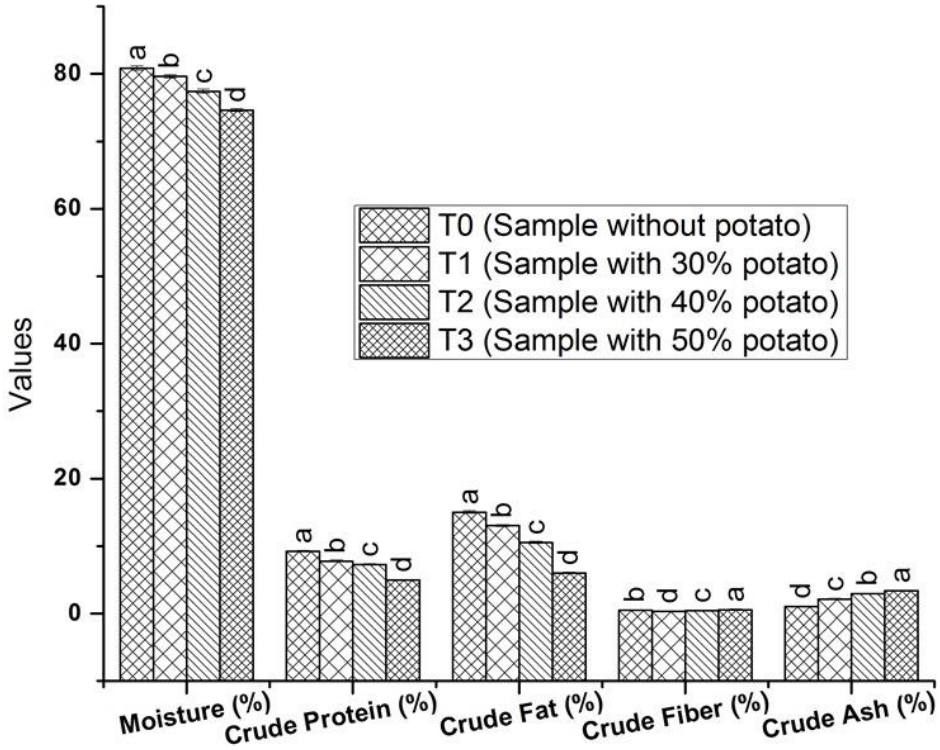

Figure 3. Effect of different treatments on the physico-chemical analysis of doughnuts.

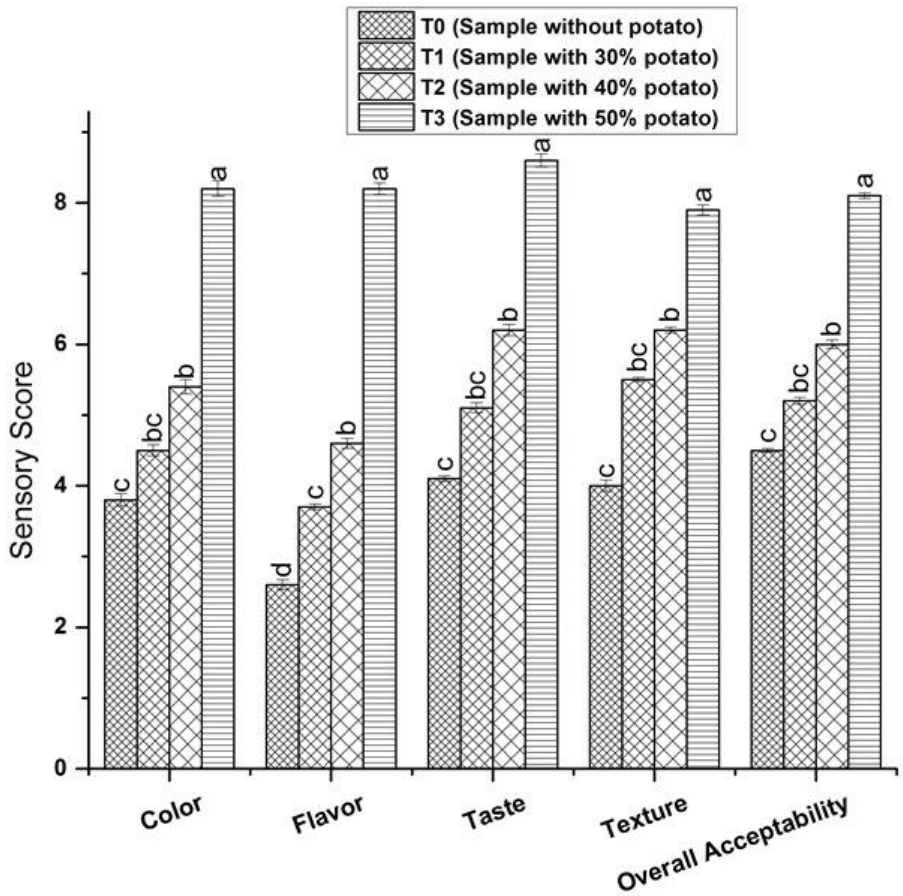

Figure 4. Effect of different treatments on the sensory characteristics of doughnuts.

The results regarding to flavor of doughnuts are presented in Figure 4. The lowest score was observed in treatment T_0 (2.6 ± 0.02) whereas highest score was observed in treatment T_3 (8.2 ± 0.09). While the sensory score of treatments T_1 and T_2 were 3.7 ± 0.04 and 4.6 ± 0.06 respectively.

The results regarding to taste of doughnuts are presented in Figure 4. The lowest score was observed in treatment T_0 (4.1 ± 0.05) whereas highest score was observed in treatment T_3 (8.6 ± 0.09). While the sensory score of treatments T_1 and T_2 were 5.1 ± 0.04 and 6.2 ± 0.07 respectively.

The results regarding the texture of doughnuts are presented in Figure 4. The lowest score was observed in treatment T_0 (4 ± 0.07) whereas highest score was observed in treatment T_3 (7.9 ± 0.09). While the sensory score of treatments T_1 and T_2 were 5.5 ± 0.05 and 6.2 ± 0.08 respectively. The texture imparts great importance to the acceptability of doughnuts. The texture of doughnuts is tremendously affected by the solid fat contents of frying oil. If there is a large quantity of solid fat contents in frying oil, then it causes brittleness in texture of doughnuts. Doughnuts with hard texture are assumed to be fried in hardened soybean oil exhibiting greater levels of solid fat contents (Hatae et al., 2003).

The results regarding the overall acceptability of doughnuts are presented in Figure 4. The lowest score was observed in treatment T_0 (4.5 ± 0.05) whereas highest score was observed in treatment T_3 (8.1 ± 0.09). While the sensory score of treatments T_1 and T_2 were 5.2 ± 0.06 and 6 ± 0.07 respectively. Our results are in accordance with the Haque et al. (2015). With the increase of potatoes up to 50% in the recipe, the doughnuts were highly acceptable by the consumers.

3.4. Principal component analysis (PCA)

PCA was used to correlate the data in order to make a relationship between doughnut samples and quality parameters. The score plots prepared from PCA of doughnut samples are presented in Figure 5a and the distribution of quality parameters defined by the first and second PCA dimensions is shown in Figure 5b. The sum of principal components PC1 and PC2 contributed to 99.3% of variance among doughnut samples.

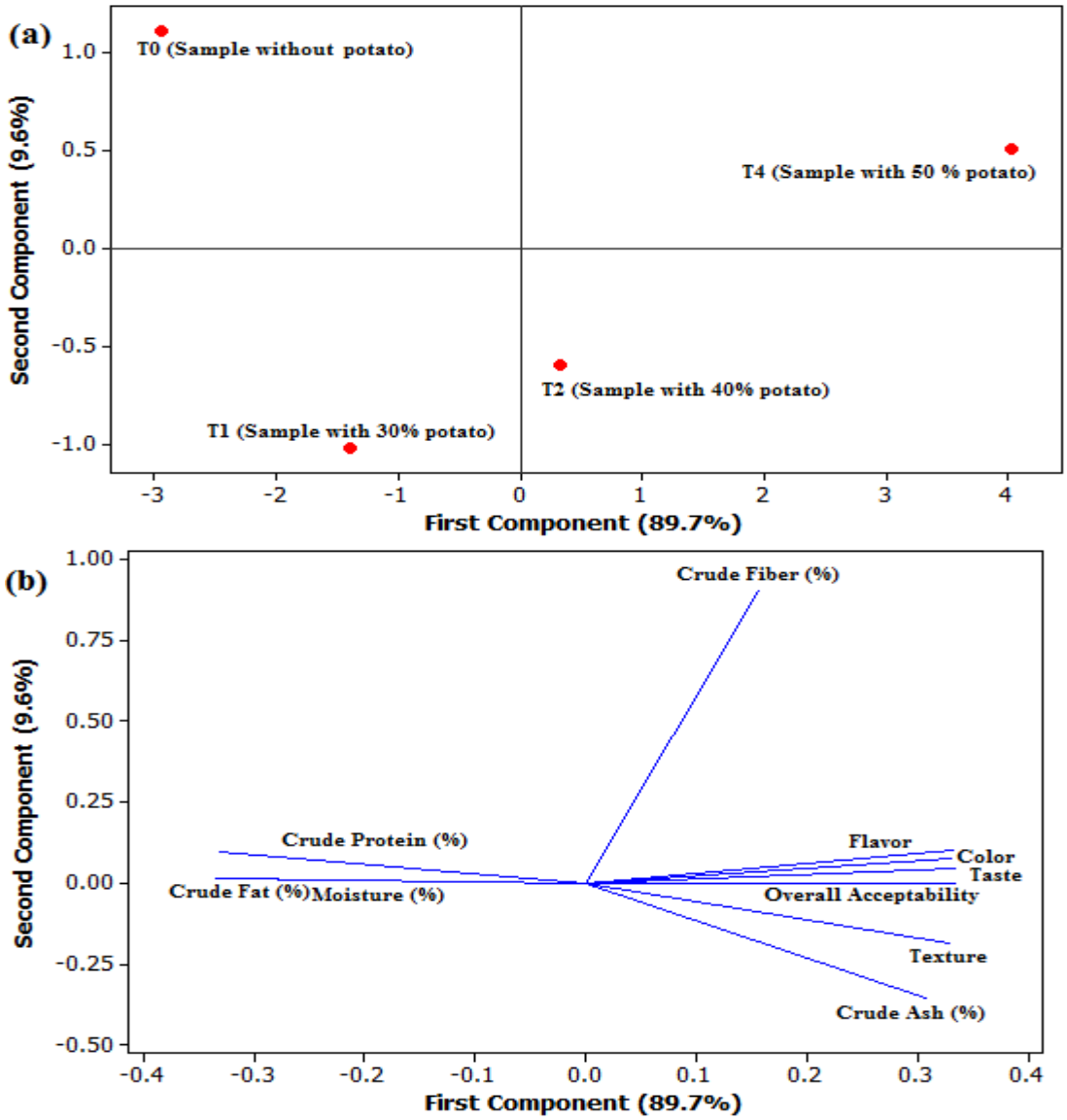

Figure 5. Principle component analysis (PCA) of doughnuts samples (a) the location of different treatments (b) the location of quality parameters

The first principal component (PC1) accounted for 89.7% of the total variation and the second principle component (PC2) contributed to 9.6% of the total variation. PC1 was positively correlated with crude fiber, crude ash, color, flavor, taste, texture and overall acceptability, and negatively with moisture, crude protein and crude fat.

4. Conclusion

In this study, small sized potatoes were used in the preparation of doughnuts. All the three treatments were acceptable, but the treatment T_3 containing 50% potato had scored highest during sensory evaluation and was liked mostly by the judges. The basic objective of improving potato utilization is to facilitate more and more incorporation and utilization of potatoes into the present dietary pattern. Potato processing has a broader range of applicability, therefore it can help in utilization of small sized potatoes and in the same way can control wastage of potatoes to a great extent by transforming potatoes in the form of doughnuts, chips, French fries, etc.

Acknowledgements

This research work was done at Institute of Food Science and Nutrition, University of Sargodha (UOS), Sargodha, Pakistan.

Competing Interests

Authors declare that they have no competing interests.

References

Abid, M., S. Jabbar, T. Wu, M.M. Hashim, B. Hu, M. Saeeduddin and X. Zeng. 2015. Qualitative assessment

of sonicated apple juice during storage. J. Food Proc. Preserv. DOI: 10.1111/jfpp.12348.

Abid, N. 1998. Evaluation of three different potato varities for preparation of potato powder through dehydration, M.Sc Thesis, Uni. of Agri. Faisalabad, Faisalabad, Pakistan.

Andani, Z. 2000. Mealiness in apples. Consumer Perception and Structure: Fruit and Vegetable Quality, CRC Press, UK, p. 158.

Anonymous. 2001. Dastarkhwan (A Recipe Manual). Plot No: 4-C Commercial Street No: 14 Phase 2 Extension, DHA, Karachi, Pakistan, pp. 32.

AOAC. 2000. Official Methods of Analysis of AOAC International. AOAC Inter. Publishers, USA.

Cliffe-Byrnes, V., L. Brennan and D. O'Beirne. 2007. The effects of preparatory procedures and storage temperature on the quality of carrot discs packaged in modified atmospheres. Inter. J. Food Sci. Technol. 42: 482-494.

Haque, E.U., M.S. Hanif, M. Nadeem, A. Mehmood, M. Ibrar, Z. Iqbal and S. Jabbar. 2015. Physicochemical and rheological study of orange pulp fortified cookies. Sci. Lett. 3: 64-67.

Hatae, K., T. Miyamoto, Y. Shimada, Y. Munekata, K. Sawa, K. Hasegawa and M. Kasai 2003. Effect of the type of frying oil on the consumer preference for doughnuts. J. Food Sci. 68: 1038-1042.

Johnson, A.H. and M.S. Peterson. 1974. Encyclopedia of Technology. The AVI Publishing Co. Inc., Westport, CT, USA, pp. 704-706.

Kaur, C. and H.C. Kapoor. 2000. Minimal processing of fruits and vegetables. Indian Food Pac., India, pp. 156.

Lachman, J. and K. Hamouz. 2005. Red and purple coloured potatoes as a significant antioxidant source in human nutrition-a review. Plant Soil Envir. 51: 477.

Larmond, E. 1977. Methods for Sensory Evaluation of Foods. Canadian Depart. of Agri., Canada.

Lee, J.S., B.K. Kim, K.H. Kim and D.J. Park. 2008. Preparation of low-fat uptake doughnut by dry particle coating technique. J. Food Sci. 73: 137-142.

Low, J.W., M. Arimond, N. Osman, B. Cunguara, F. Zano and D. Tschirley. 2007. A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. J. Nutr. 137: 1320-1327.

Luh, B.S., Feinberg, B.L. and J.J. Meehan. 1975. Freezing Preservation of Vegetables in Commercial Vegetable Processing. In: B.S. Luh and J.G. Woodroof (Ed). The AVI Publishing Company Inc., Westport, Connecticut, USA, p. 317-359, 677-678.

Malik, N.J. 1995. Potatoes in Pakistan: A Handbook, Pak-Swiss Potato Development Project, Pak. Agri. Res. Coun.

Marwaha, R. 1999. Chipping quality and related processing characteristics of Indian potato varieties grown under short day conditions. J. Food Sci. Technol. 36: 157-159.

Philips, R. and M. Rix. 1993. Vegetables. Random House, Inc. , New York, USA, p. 270.

Rehman, S.U., A. Paterson, S. Hussain, M.A. Murtaza and S. Mehmood. 2007. Influence of partial substitution of wheat flour with vetch (*Lathyrus sativus* L) flour on quality characteristics of doughnuts. LWT-Food Sci. Technol. 40: 73-82.

Reyes, L.F., J.C. Miller and L. Cisneros-Zevallos. 2005. Antioxidant capacity, anthocyanins and total phenolics in purple-and red-fleshed potato (*Solanum tuberosum* L.) genotypes. American J. Potato Res. 82: 271-277.

Rumbaoa, R.G.O., D.F. Cornago and I.M. Geronimo. 2009. Phenolic content and antioxidant capacity of Philippine sweet potato (*Ipomoea batatas*) varieties. Food Chem. 113: 1133-1138.

Sapers, G. and R. Miller. 1993. Control of enzymatic browning in pre-peeled potatoes by surface digestion. J. Food Sci. 58: 1076-1078.

Shah, A.H., S.H. Shah, Z.A. Swatiand Z. Hussain. 2003. Cost effective micropropagation technology for potatoes. Pak. J. Bio. Sci. 6: 336-340.

Temple, V.J., C.E Onobun,. and T.O. Ojobe. 1991. Chemical composition of livingstone potato tubers (*Plectranthus esculentus*). J. Sci. Food Agri. 56: 215-217.

Woolfe, J.A. and S.V. Poats. 1987. The Potato in the Human Diet, Cambridge Uni. Press, Lima, Peru.

Xu, X., S. Pan, S. Cheng, B. Zhang and D. Mu et al. 2011. Genome sequence and analysis of the tuber crop potato. Nature. 475: 189-195.