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Research Article

Proximate Composition of Qolxo (*Arisaema Schimperianum Schott*) and Different Processing Effect on its Composition

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ABSTRACT

Qolxo is a local name of (Arisaema schimperianum schott) in the study area. Qolxo is an herbaceous tuber crop that belongs to the family Araceae and subfamily Aroideae. They provide important plant foods for many indigenous people of the tropics and subtropics. However, some members of this family are not comfortable with safe consumption. It forms needle-like raphides of calcium oxalate crystals, that responds to the food to acridity, irritation, inflammation and burning sensation followed by swelling of hands, mouth, lips and throat irritation as major causes for the health-related problems. Proximate compositions of qolxo were determined by using AOAC. Two different levels of processing (heating and soaking) treatment combinations of qolxo were analysed by ANOVA followed by a completely randomized design. Different processing treatments were significantly ($p<0.05$) influenced the proximate compositions of qolxo. There was an elevation trend of carbohydrates observed in processed qolxo. A however slight reduction of other proximate content in all treatments than control. Generally, the proximate composition in fresh and processed qolxo was observed as a relative with other tuber root crops.

Keywords: Qolxo; Proximate composition; Processing effects

INTRODUCTION

Qolxo is a local name of (Arisaema schimperianum schott) in Dita and neighbor high land woredas of Gamo zone, Southern Ethiopia. Qolxo is herbaceous tuber crop that belongs to the family Araceae and subfamily Aroideae in the area. There are 105 genera and over 2000 species of the family found in all climatic regions of the world, but mainly in tropical or subtropical. Also reported that some qolxo species are rich in nitrogen and the amount of starch present is as high as in many bowls of cereal [1-2]

According to root and tuber crops (cocoyam and potato) are high in carbohydrate content of 86.53% and 83.21% respectively. Also, it is reported that the carbohydrate content of root and tuber crops are generally rich in carbohydrates hence, their high caloric values. The caloric values obtained for these two crops are more than that of cassava, Irish potato, sweet potato, yam and taro. According to grinding may affect the hydration properties, in particular, the kinetics of water uptake as the result of the increase of surface area, the fibres hydrate more rapidly. In wheat bran, it has been found that thermal treatments (boiling, cooking or roasting) originate an increase of total fibre that is not due to a new synthesis, but rather to the formation of crude fibre-protein complexes that are resistant to heating and are quantified as dietary crude fibre [3-5-8].

The processing required making some root and tuber crops, vegetables and legumes suitable for eating causes a decrease of several components of the fibre. For example, during cooking of lentils previously dipped, the quantity of fibre diminishes, fundamentally due to a great decrease in hemicelluloses. As reported by the solubilization of polysaccharides resulted in decreased total fibre content mainly due to loss of soluble fibre, during thermal processing of kidney beans. The effect of thermal treatment (including extrusion cooking, boiling and frying) on the dietary crude fibre composition of cereals and potato samples were studied at eight laboratories using different analytical methods. They reported that heat-treated potato samples contained more water-insoluble dietary fibre and less starch than raw samples. No changes were observed in the amounts of dietary fibres and starch in the extruded samples [9-12].

According to the global contribution of proteins from roots and tubers in the diet is less than 3%. However, in African countries, this contribution may vary from 5% to 15%. The chemical composition

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of qolxo was not analyzed before, but in the area growing roots and tuber crops including taro, yam, cocoyam, potato are reported as generally low in protein; hence, food products from these crops should be supplemented with other high-protein products for balanced nutrition [5]. Processing like cooking and boiling resulted in more availability of protein. The cooking process leads to breakage of the tannin-protein complex thereby limiting the protein availability in food [9-13].

The protein contents of roots and tuber crops are variable. In selected root and tuber crops (cocoyam, potato, cassava and yam) the protein content of roots and tubers is low ranging from 1% to 2% on a fresh weight [14], but potatoes and yams contain high amounts of proteins among other tubers. Also [15] reported that the crude protein contents of fresh cocoyam 6.40% and fresh potato 10.34%, but after processing the protein content was found 8.96% and 10.41% for cocoyam and potato respectively. The report of shown that the ash contents of cocoyam tuber have ranged from 3.65% to 4.09% and potato has ranged from 3.93% to 4.58%. In addition, the research has reported that the potato tuber had significantly higher values whether cooked or uncooked than cocoyam tuber. However, the ash levels in the two tubers were reduced in the course of the cooking, which could be attributed to the solubilization and leaching of nutrients into the processing water. According to ash content of three cocoyam cultivars in Nigeria ranged from 4.60% to 7.78 %. As a report of that all root crops exhibit very low-fat content. Similar reports were recorded by who reported that the crude fat content values ranging from 0.17% to 0.21% in six potato varieties. The higher fat contents in processed (cooked) food could increase the extractability of the more polar fat or fats that are bound to other macro constituents in the tissue. This does not pose a problem in crude fat, even when cooked [3]. Dita area of the Gamo zone is a hilly area that is generally affected by drought conditions. Such is the area of insufficient food production the situation becomes more adverse as and when there is drought. Thus the local population has no available food source. Under such conditions, qolxo tubers are generally considered a major alternate food source for the local population [14-19].

A large area in Ethiopia falls under rough and inaccessible terrain. Dita is a sub-administrative zone of Gamo which has rough terrain. The population makes their livelihood by rearing cattle, growing crops like cereals (barley and wheat), legumes (bean, pea and haricot bean), and root crops (sweet potato, potato, taro and yam). The production of these crops is much lower than the food requirement of the area. The cultivated crops provide food to the population for a short period of the year, but in most of the months especially from September to November, there is an acute food shortage. For their survival, the local population has explored the use of wild tuber crop (qolxo) growing in the area for their food during the food scarcity period.

However, even though the qolxo tuber satisfies hunger, most people experience some discomforts after consumption such as lips and throat irritation, kidney failure, stomach disturbance, night blindness, edema and other health problems. Health problems caused after consuming qolxo is considered to be of the same nature. Following to survey report from the local population, except for hungry satisfaction, there was no pre-bench marked information about the proximate composition of qolxo, But within a season of series consumption, there was an acute problem faced by consumers like night blindness, stomach disturbance and so on. It also responds to the acridity, irritation, inflammation and burning sensation followed by swelling of hands, mouth, lips and throat irritation as major causes for the health-related problems. Therefore, this study was initiated to investigate the proximate composition for safe consumption in the qolxo tuber. If these problems are overcome, qolxo can provide suitable alternate food for the area as these tubers do not need heavy investment for cultivation. The present study was conducted to find the proximate composition of qolxo and its nutritional contents as influenced by different processing methods.

MATERIALS AND METHODS

Description of the area

This study was conducted in two areas; one is Dita Woreda which is a sub-administrative zone of Gamo that is used for qolxo tuber collection and, another area is Arba Minch University which is one of Ethiopian governmental universities, used for qolxo tuber processing and analysis. The qolxo tuber for the present studies was procured from the farmers of Dita located in Gamo, Southern Ethiopia. Dita is about 58 km from Arba Minch town and 603 km from the capital city of Ethiopia, Addis Ababa. In Dita the tuber was collected from two locations namely Giyassa and Dalbansa, which are located at an altitude ranging from 1700-2400 meter above sea level 6°11.5' N latitude and 37°29.5'E longitude (Figure1). The topography of this study area is hilly, with a 13% slope and a clay loam soil texture with 77% aluminium saturation [20].

Sample collection

Qolxo tubers were collected from Dita Woreda Gamo sub-administrative zone. This area is known in Ethiopia for the production and consumption of qolxo for food purposes in the case of the off season. To give proper coverage to the area two similar sites were selected in the area for the collection of qolxo tubers. Qolxo samples are comprised of different sized tubers (large, medium and small) and free from mechanical and pest damage. Samples were directly purchased from randomly selected farmers, they were packed in polyethene plastic bags after ensuring uniformity, labelled and transported to Horticulture and Chemistry Department, Arba Minch University for processing and Ethiopia Public health Research Institute, Addis Ababa for analysis.

Lemon fruit having the uniform size, shape, colour and free from any mechanical and pest damaged was purchased from a sickle local market, Arba Minch town. Lemon juice extraction was completed manually after cutting the fruit into two parts and the juice extract was collected in a plastic jock. The ginger root which has the same freshness, mechanical and pest damage-free was purchased from a sickle local market, Arba Minch town. Extraction was completed by using a juice maker after finely slicing with a steeliness steel knife and the juice extract was collected in a plastic jock. Alcohol/ethanol was purchased from the local alcohol and processing house of Arba Minch town.

Qolxo sample preparation

Qolxo sample soaking: Qolxo samples were gently washed and peeled carefully using stainless steel knives. The peeled qolxo

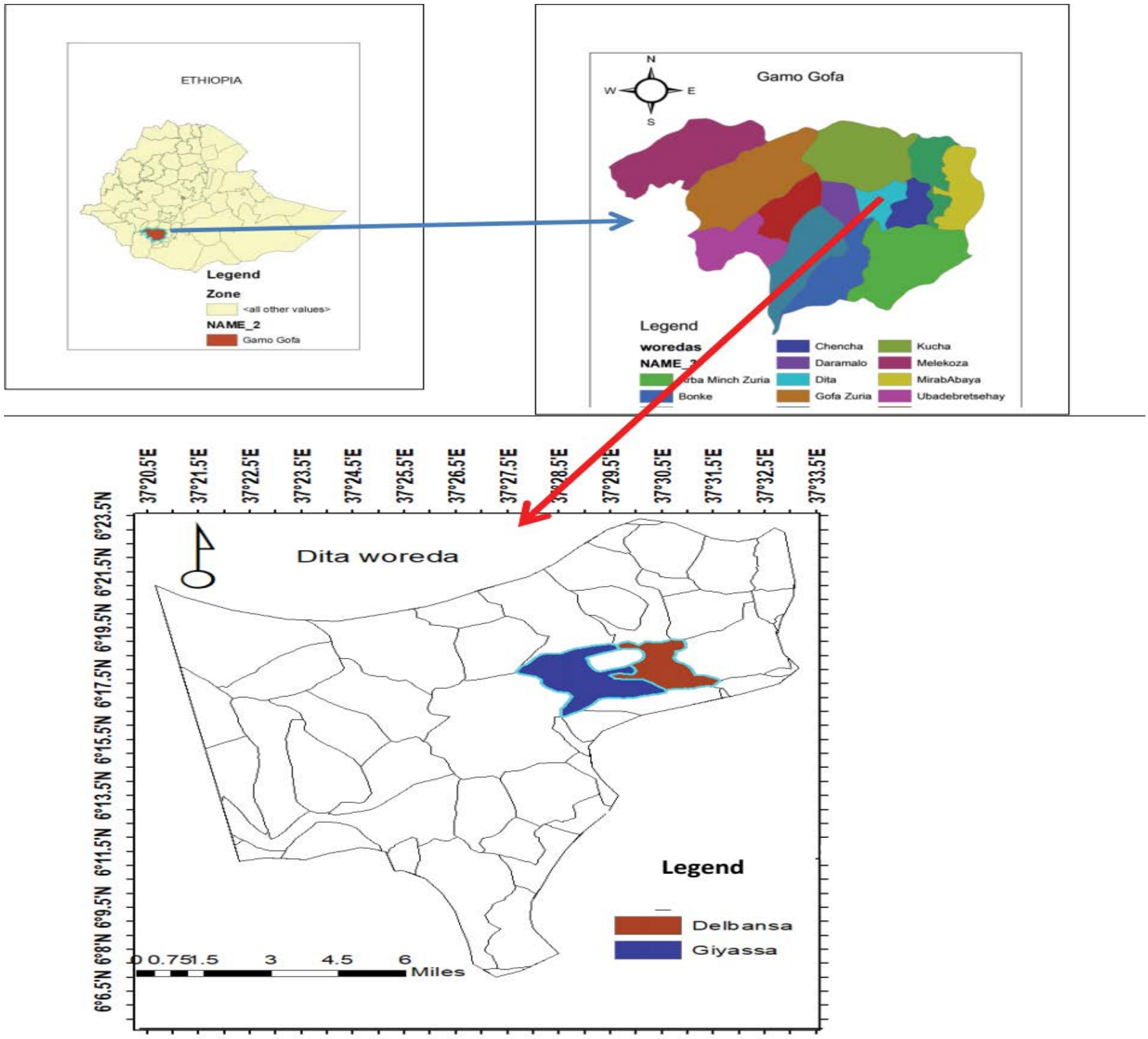

Figure 1: Map of the study area.

samples were washed, rinsed with deionized water and then sliced to a uniform size of three centimeter, and distributed in different four lots. Each of the lots was sub-divided in to three sub-lots. Three sub-lots were separately soaked in 1:2 ratio of qolxo slice in kilogram to solutions in liter for two days at room temperature in the solutions of ethanol, ginger juice and lemon juice having its pH value of 5.12, 3.59 and 2.01 respectively. Three sub-lots were not soaked in any solution. Each solution was drained off after soaking process completed. For each of treatment one out of the three lots was subsequently boiled in water, one was dried in oven and one was neither boiled nor dried.

Qolxo sample boiling: After soaking the qolxo slices in three different solvents, one sub-lot from each solvent was used for boiling at 100°C in potable water for 20 minutes. The boiling water was discarded after boiling process completed. The boiling process was performed using an electrical heating of (model-GMP-MSI-83, China).

Qolxo sample drying: The second sub-lot of each treatment was dried in oven dry (model GX-3020, GAOXIO, Co, Ltd, China) at 70°C for 15 hours. The third sub-lot was neither dried nor boiled which is referring to the farmers practice (control).

Proximate composition analysis

Moisture determination: The method described was used to determine moisture content of qolxo samples. The method was based up on the removal of water from the sample and its measurement by loss of weight. Clean crucible was weighted and dried in the oven (w1), 1 g of each sample was weighted in to crucible (w2) and dried at oven 105°C for 24 hours. The crucibles were transferred from oven to desiccator, cooled and re-weighted (w3). The percentage of moisture content was calculated as:

$$\frac{w_2 - w_3}{w_2 - w_1} \times 100$$

Ash determination: The method was used to measure the ash content of qolxo sample. The porcelain crucibles were dried in an oven at 100°C for 10 min cooled in a desiccator and weighed (w1). Two gram of the sample placed into the previously weighed porcelain crucible and reweighed (w2) and then placed in the furnace for four hours at 600°C to ensure proper ash. The crucible containing the ash was removed cooled in the desiccator and weighed (w3). The ash content of qolxo was calculated as:

$$\frac{w_3 - w_1}{w_2 - w_1} \times 100$$

Crude fiber determination: The method described by was used. As original sample (w0) one gram of the finely ground sample was weighed out into a round bottom flask, 100 ml of 1.25% sulphuric acid solution was added and the mixture boiled under a reflux for 30 minutes. The hot solution was quickly filtered under suction. The insoluble matter washed several times with hot water until it was acid free. It was quantitatively transferred into the flask and 100 ml of hot 1.25% sodium hydroxide solution added and the mixture boiled again under reflux for 30 min and quickly filtered under suction. The soluble residue washed with boiling water until it was base free. It was dried to constant weight in the oven at 105℃, cooled in a desiccator for 30 min and weighed (w1). The weighed sample (w1) was incinerated in a muffle furnace at 300°C for about 30 min, cooled in the desiccator for 30 minutes and reweighed (w2). The loss in weight of sample on incineration was calculated as:

$$\frac{w_1 - w_2}{w_0} \times 100$$

Crude fat determination: The qolxo fat content was determined as with method of [21]. Known amount of sample (w0) in a round bottom flask, containing few anti-bumping granules weighed (w1) and 150 ml of petroleum ether was transferred into the flask fitted with Soxhlet extraction apparatus. The round bottom flask and a condenser were connected to the Soxhlet extractor and cold-water circulation was put on. The heating mantles are switched on and the heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for 6 hr. The round bottom flask and extracted oil are cooled and then weighed (w2) and the fat content of qolxo sample was calculated as:

$$\frac{w_2 - w_1}{w_0} \times 100$$

Crude protein determination: Crude protein was determined by method described by [1]. 1 g of each sample was weighed into separated digestion flask and 10 g of a catalyst sodium sulphate, copper sulphate and 25 ml of concentrated Sulphuric acid was added. The sample heated on a micro digestion bench which is thermostatically controlled to remove organic carbon for 2 hrs. After heating, the content of the flask was left to cool and transferred to a round bottom flask with distilled water. A little piece of anti-bumping granules was added to prevent pumping and 80 ml of 40% sodium hydroxide solution carefully added, mixed and then subjected to distillation until all the ammonia passed over into the standard sulfuric acid solution. It was titrated with standard 0.55 M of sodium hydroxide solution to an end point. The conversion factor 6.25 was used to get the percentage protein contents [21].

Carbohydrate determination: The total carbohydrate content was determined by followed [22] method. The percentage sum of the moisture, ash, crude protein and crude fiber was subtracted from 100. Total carbohydrate content of qolxo sample was calculated as: 100 minus percentage of (moisture+Ash+fat+protein+fiber) [22].

RESULTS AND DISCUSSION

Proximate composition on qolxo

Moisture content: Moisture content of the raw and processed qolxo is presented below in Table 1. The moisture content of 32.39% on fresh weight was recorded in fresh qolxo, whereas it ranged from 11.57% to 30.48% in the processed one. A moisture percentage of 11.57%, 12.58%, 12.62% and 14.71% was observed in dried qolxo treated with ginger juice, oven dried qolxo, and dried qolxo treated with ethanol and dried qolxo treated with lemon juice respectively. This could be due to removal of water during drying. These results are in close conformity to the report of who reported moisture content of 11% to 16.5% in all dried root and tuber crops. High moisture content of dried root crops reduces shelf life and permits microbial growth constituting health hazards for animal feeding on such products [23,24].

Table 1: Interaction effect of heating and soaking on proximate composition of qolxo in percent.

Treatments	Moisture	Crude fiber	Total ash	Crude protein	Crude fat	Carbohydrate
Control	32.39 ± 0.98	0.59 ± 0.021	1.34 ± 0.005	0.54 ± 0.017	0.11 ± 0.1	65.45 ±1.3^{h}
Fresh qolxo treated with ginger	29.23 ± 1.11	0.46 ± 0.37	1.41 ± 0.005	0.48 ± 0.006	0.19 ± 0.001	68.21 ± 1.09
Fresh qolxo treated with lemon	27.92 ± 0.62	0.43 ± 0.26	1.38 ± 0.005	0.61 ± 0.06	0.16 ± 0.001	68.85 ± 0.54
Fresh qolxo treated with ethanol	30.48 ± 0.53	0.47 ± 0.037	1.33 ± 0.01	0.42 ± 0.006	0.15 ± 0.05	67.13 ± 0.56
Boiled qolxo with not soaked	18.36 ± 0.8	0.41 ± 0.0046	2.74 ± 0.01	0.52 ± 0.01	0.20 ± 0.005	77.75 ± 0.81
Boiled qolxo treated with ginger	17.68 ± 0.76	0.45 ± 0.07	2.22 ± 0.01	0.42 ± 0.057	0.20 ± 0.005	79.00 ± 0.74
Boiled qolxo treated with lemon	18.33 ± 1.12	0.52 ± 0.01	1.98 ± 0.005	0.47 ± 0.005	0.24 ± 0.01	78.49 ± 1.06
Boiled qolxo treated with ethanol	19.60 ± 0.68	0.48± 0.006	2.51 ± 0.3	0.53 ± 0.007	0.15 ± 0.01	76.68 ± 0.84
Dried qolxo with not soaked	12.85 ± 0.69	0.73 ± 0.01	1.97 ± 0.005	0.82 ± 0.0057	0.13 ± 0.00	82.81 ± 0.45
Dried qolxo treated with ginger	11.57 ± 0.52	0.75 ± 0.009	1.86 ± 0.005	0.62 ± 0.0066	0.12 ± 0.01	85.05 ± 0.51
Dried qolxo treated with lemon	14.71 ± 0.59	0.78 ± 0.005	1.78 ± 0.005	0.44 ± 0.007	0.11 ± 0.02	82.12 ± 0.06
Dried qolxo treated with ethanol	12.62 ± 0.70	0.82 ± 0.01	1.88 ± 0.01	0.61 ± 0.005	0.14 ± 0.01	83.91 ± 0.72
CV%	3.87	5.01	5.4	3.64	6.12	1.07
LSD	1.3373	NS	0.1704	NS	NS	1.3841

Means followed by the same letter (s) within a column are not significantly different at $p < 0.05$%; CV: coefficient of variation, LSD: Least significant difference and NS: Not significant.

Carbohydrate: Carbohydrate content of the raw and processed qolxo is presented below in Table 1.The carbohydrate content of 65.45% on fresh weight was recorded in fresh qolxo, whereas it ranged from 67.13% to 85.05% in processed qolxo. A highest carbohydrate percentage of 85.05% and 83.91% were observed in dried qolxo treated with ginger juice and dried qolxo treated with ethanol respectively, whereas the lowest percent of 65.45% was observed in unprocessed qolxo. That could be due to the removal of water during drying. Though the composition of fresh qolxo in respect of carbohydrate has been reported 65.94% to (Arisaema concinnum) but no literature is available on the carbohydrate content in processed qolxo. The other root and tuber crops growing in the study area were studied by who reported carbohydrate content of 86.79%; 79.67% and 79.36% in Potato; Sweet potato and yam respectively, in fresh crops. Comparing the qolxo carbohydrate content with the finding of earlier works for potato, sweet potato and yam it can concluded that the qolxo serve a source for carbohydrate supply like other root and tuber crops commonly being consumed. In the present studies dried qolxo treated with ginger juice had the highest carbohydrate content of 85.05%, which is comparable to the carbohydrate content in dried root and tuber crops reported by who reported carbohydrate percentage of 86.79% in Potato, 79.67% in Sweet Potato, 79.36% in Yam, 76.42% in Cassava and 75.93% in Dalo [25,26].

Crude protein: Crude protein content of the raw and processed qolxo are presented above in Table 1. The crude protein content of 0.54% on fresh weight bases was recorded in fresh qolxo, whereas it ranged from 0.42%-0.82% in processed qolxo. A crude protein content of 0.82%, 0.62%, and 0.61% was observed in oven dried qolxo not soaked, dried qolxo treated with ginger juice, and dried qolxo treated with ethanol respectively. Oven dried qolxo not soaked had highest protein content (0.82%), whereas dried qolxo treated with ethanol had lowest protein content (0.42%). That could be due to that alcohol-soluble protein fractions solubilized and precipitated in ethanol solution and drained off with ethanol. These variations could be probably due to variety, location maturity and processing technique difference [26]. Though there is no literature available on the protein content of processed qolxo, but the reports of earlier research on the other root and tuber crops indicate that crude protein content of African yam is 4.5% and also it is reported that African yam having highest crude protein 7.66% and lowest value in cassava 3.72% [27-28].

Crude fat: Crude fat content of the raw and processed qolxo is presented above in Table 1. A crude fat content of 0.11% on fresh weight bases was recorded in fresh qolxo, whereas it ranged from 0.11%-0.24% in processed qolxo. The highest fat content 0.24% was observed in boiled qolxo treated with lemon juice followed by boiled qolxo treated with ginger juice 0.20%. This variation of fat could be probably due to boiling temperature increase extractability of the more polar fat or fats that are bound to other macro constituents in the qolxo tissue. These findings are close to the results of who reported that the root and tuber meal contains fat content ranges from (0.1-0.3%) on a dry weight basis [29].

Total ash: Ash content of the raw and processed qolxo is presented above in Table 1. The ash content of 1.34% on fresh weight was recorded in fresh qolxo, whereas it ranged from 1.33%-2.74% in processed qolxo. The highest ash content of 2.74% and 2.51% was observed in boiled qolxo and boiled qolxo treated ethanol respectively, whereas the lowest ash of 1.33% was observed in fresh qolxo treated with ethanol. That may be due to leaching of soluble minerals in low pH solution and damaging of cell wall of the qolxo resulting in leaching of not only the dissolved ones, but also those dispersed in the solution. As the report of that unprocessed qolxo ash content of 7.6% on (Arisaema concinnum), thus this studies contrary the ash percentage. This could be due to the species difference and that leaching of soluble minerals drained off with soaked solvents and boiling water. Processing of qolxo like (washing, slicing, blanching or cooking) causes statistically significant decrease in ash [30,31].

The percentage of ash content in sample gives an idea about the inorganic content of the samples from where the mineral content could be obtained. Samples with high percentages of ash contents are expected to have high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development [32].

Crude fiber: Perusal of Table 1 reveals that crude fiber content of 0.59% on fresh weight was recorded in fresh qolxo, whereas in case of qolxo treated with ginger juice it was 0.46%; qolxo treated with lemon juice 0.43%; qolxo treated with ethanol 0.47%; boiled qolxo not soaked 0.41%; boiled qolxo treated with ginger juice 0.45%; boiled qolxo treated with lemon juice 0.52%; boiled qolxo treated with ethanol 0.48%; dried qolxo not soaked 0.73%; dried qolxo treated with ginger juice 0.75%; dried qolxo treated with lemon juice 0.78% and dried qolxo treated with ethanol 0.82%. Thus, the highest crude fiber content of 0.82% was observed in dried qolxo treated with ethanol whereas the lowest crude fiber content of 0.41% was observed in boiled qolxo not soaked. This could be mainly due to the loss of soluble fiber during boiling and drained off with boiling water. This study is in line with the work who reported that crude fiber does not exceed (1.5%) in fresh root crops and (4%) in processed root crops depending on the variety and the age of the root.

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REFERENCES

1. Hinrichs J. Mediterranean milk and milk products. Eur J Nutr. 2004;43:i12-17.
2. Farah Z. Composition and characteristics of camel milk. J Dairy Res. 1993;60:603-626.
3. Gorban AM, Izzeldin OM. Mineral content of camel milk and colostrum. J Dairy Res. 1997;64:471-474.
4. Omer RH, Eltinay AH. Changes in chemical composition of camel's raw milk during storage. Pak J Nutr. 2009;8:607-610.
5. Magjeed NA. Corrective effect of milk camel on some cancer biomarkers in blood of rats intoxicated with aflatoxin B1. J Saudi Chem.Soc. 2005;9:253-263.
6. Shabo Y, Barzel R, Margoulis M, Yagil R. Camel milk for food allergies in children. IMAJ-RAMAT GAN.2005;7:796.

7. Farah Z, Rettenmaier R, Atkins D. Vitamin content of camel milk. Int J Vitam Nutr Res.1992;62:30-33.

8. Al Kanhal HA. Compositional, technological and nutritional aspects of dromedary camel milk. International Dairy Journal. 2010;20:811-821.

9. Desouky MM, Shalaby SM, Soryal KA. Compositional, rheological and organoleptic qualities of camel milk labneh as affected by some milk heat treatments. World J Dairy Food Sci. 2013;8:118-130.

10. Farah Z. Milk production. 2005:25-28.

11. Smith CG, Vane JR. The discovery of captopril. FASEB J. 2003;17:788-789.

12. Pan D, Luo Y, Tanokura M. Antihypertensive peptides from skimmed milk hydrolysate digested by cell-free extract of Lactobacillus helveticus JCM1004. Food Chem. 2005;91:123-129.

13. Alhaj OA, Kanekanian A, Peters A. The effect of *Bifidbacterium* lactic and trypsin on cholesterol. International Food and Health Innovation Conference. 2006.

14. Li GH, Le GW, Shi YH, Shrestha S. Angiotensin I-converting enzyme inhibitory peptides derived from food proteins and their physiological and pharmacological effects. Nutr Res. 2004 ;24:469-486.

15. Fandiño L R, Otte J, Van Camp J. Physiological, chemical and technological aspects of milk-protein-derived peptides with antihypertensive and ACE-inhibitory activity. Int Dairy J. 2006;16:1277-293.

16. Pereira DI, Gibson GR. Effects of consumption of probiotics and prebiotics on serum lipid levels in humans. Crit Rev Biochem Mol Biol.2002;37:259-281.

17. Kamal AM, Salama OA, El Saied KM. Changes in amino acids profile of camel milk protein during the early lactation. Int Dairy J. 2007.

18. Agamy EESI, YP Park, GFW Haenlein. Handbook of Milk of Non-Bovine Mammals. Oxford: Blackwell Publishing.2006: 297-344.

19. Benkerroum N. Antimicrobial activity of lysozyme with special relevance to milk. Afr J Biotechnol. 2008;7.

20. El Agamy EI. The challenge of cow milk protein allergy. Small Rumin Res. 2007;68:64-72.

21. Businco L, Bruno G, Giampietro PG, Cantani A. Allergenicity and nutritional adequacy of soy protein formulas. J. Pediatr. 1992;121:S21-S28.

22. Malik A, Senaidy AA, Skrzypczak J E, Jankun J. A study of the anti-diabetic agents of camel milk. Int J Mol Med. 2012;30:585-592.

23. Elimam A, Baragob A. Therapeutic value of camel milk as antiulcerogenic effect against ethanol-induced gastric ulcers in rats. Biotechnology and Biochemistry Research.2014;2:32-36.

24. Zagorski OL, Maman AR, Yaffe A, Meisler A, Van Creveld CL, Yagil RE. Insulin in milk-a comparative study. Int J Anim Sci. 1998;13:241-244.

25. Barbour EK, Nabbut NH, Frerichs WM, Nakhli AHM. Inhibition of pathogenic bacteria by camel's milk: relation to whey lysozyme and stage of lactation. J Food Prot. 1984;47:838-840.

26. Harrington P, Archer J, Davis JP, Croft DR, Varma JK, Officers E. Outbreak of Campylobacter jejuni infections associated with drinking unpasteurized milk procured through a cow-leasing program-Wisconsin, 2001. MMWR 2002;51:548-549.

27. Aly SA, Elewa N. Hazards associated with dromedary camel milks. Int j Sci Nat. 2014;5:412-417.

28. Mohamed IM, El Zubeir IE, El YM. Effect of heat treatment on keeping quality of camel milk. Ann. Food Sci. Technol. 2014;15:239-245.

29. Nagy P, Juhasz J, Marko O. Production of high quality raw camel milk. Determination of major Control points in a largescale camel milking farm. International Camel Conference. 2007.

30. Ani AFK. The urinary system. Camel Management and Diseases. Al-Sharq printing press. 2004:263-267.

31. Wernery U. Camel milk-new observations. International Camel Conference" Recent trends in Camelids research and Future strategies for saving Camels". 2007:200-204.

32. Dukwal V, Modi S, Singh M. A comparative study of nutritional composition of camel and cow's milk. Int Camel Conf. 2007;7:91-92.

33. Muliro PS, Shalo PL, Kutima PM. Quality assessment of raw camel milk using dye reduction tests. Afr J Food Sci.tech. 2013;4:116-121.

34. Takela D. Effect of sisal foil wrapped milk containers on quality parameters of camel milk. Glob J Med Res. 2014

35. Wangoh J. Chemical and technological properties of camel (*Camelus dromedarius*) milk. 1997

36. Gansaikhan O, Batsukh T, Ichinhorloo Z. Physico-chemical quality of Bactrian camel milk. Mong. J Chem. 2011;12:50-52.

37. Schwartz HJ, Dioli M. The one-humped camel in Eastern Africa. A pictorial guide to diseases, health care and management.1992.

38. Thiagarajan TR. Ship of the desert. The Hindu. 2001:1-3.

39. Atherton HV, Newlander JA. Chemistry and testing of dairy products. AVI Publishing. 1977.

40. Agrawal RP, Beniwal R, Kochar DK, Tuteja FC, Ghorui SK, Sahani MS, et al. Camel milk as an adjunct to insulin therapy improves long-term glycemic control and reduction in doses of insulin in patients with type-1 diabetes A 1 year randomized controlled trial. Diabetes Res Clin Pract.2005;68:176-177.

41. Composition of camel milk and milk products of camel. 2010

42. Milking the camel. FAO. 2006

43. Faraz A, Mustafa MI, Lateef M, Yaqoob M, Younas M. Production potential of camel and its prospects in Pakistan. J Zooology. 2013;28:89-95.

44. Ahuya CO, Okeyo AM, Peacock C. Developmental challenges and opportunities in the goat industry: the Kenyan experience. Small Rumin Res. 2005;60(1-2):197-206.

45. Hoffmann I. Climate change and the characterization, breeding and conservation of animal genetic resources. Anim genet. 2010;41:32-46.

46. Hand book on milk collection in warm developing countries. International Dairy Federation (IDF). 1990.

47. Hamad MN, Baiomy AA. The physical and chemical properties of camel's and sheep's milk in qena governorate. J. food. Dairy Sci. 2010;1:405-412.