Discourse Journal of Agriculture and Food Sciences
www.resjournals.org/JAFS
ISSN: 2346-7002
Vol. 6(2): 11-16, March, 2018

A Comparative Study of Physicochemical Properties of Freeze-dried Camel's Milk and Cow's Milk Powder

Abdel Moneim E. Sulieman[1], Osama M. Elamin[2], Elamin A. Elkhalifa[2] and Loouis Laleye[3]

[1]Department of Biology, faculty of Science, University of Hail, Kingdom of Saudi Arabia
[2]Department of Food Science and Technology, Faculty of Engineering and Technology, University of Gezira, Wad-Medani, Sudan
[3]Department of Food Science, Faculty of Agriculture, University of Al-Ain, United Arab Emirates

Abstract

In the present study, fresh raw camel and cow's milk were concentrated to 20-30% total solids, and then freeze-dried under the temperature of (-50 °C to -75 °C), under vacuum. The physicochemical characteristics of the various freeze-dried powders were determined. The water activity (aw) of freeze-dried camel milk (FDC) and freeze-dried cow milk (FDW) ranged 0.253-0.307 and 0.148- 0.301, respectively. While aw of the commercial milk sample (CMD) was 0.326. Both FDC and FDW had reasonable flowability as indicated by measuring their hausner ratio which ranged between 1.15 and 1.24. FDC had higher insolubility index (0.65-0.85) when compared with those of FDW(0.25-.055). The yield and hygroscobisity of freeze-dried samples ranged between (81.42-94.57) and 22.12-27.32, respectively. The measurements for colour characteristics indicated that the lightness ranged between 91.20 and 94.34 while the commercial sample had a value of 94.45. All samples had acceptable lightness, yellowness and redness when compared with those of the commercial sample. Small variation were determined in some of the chemical components of the various samples of FDC, FDC and CMD. It is recommended in the present investigation that freeze-drying of milk could be an extremely effective method for producing dried powder from camel and cow's milk with little changes in most nutrient compounds.

Keywords: Freeze drying, water activity, flow-ability, acidity, concentration, protein.

INTRODUCTION

The dromedary camel, otherwise called the Arabian camel, exists today only as a domesticated animal. About 90 percent of the world's camels are dromedaries. There are two types of Bactrian camels: wild and domesticated. A camel can go possibly more than seven days without water, and it can last for several months without food. It can survive a 40 percent weight loss and then drink up to 32 gallons (145 liters) of water in one drinking session (http://animals.sandiegozoo.org/animals/camel).

Camel milk is an important source of proteins for the people living in the arid lands of the world. Camel milk is also known for its medicinal properties, which are widely exploited for human health, as in several countries from the ex-Soviet Union and developing countries (Kenzhebulat*et. al*., 2000; Mal *et. al*, 2006; Yoganandi*et.al*., 2015).

Camel milk and camel milk products have dependably been exceedingly regarded playing even today an imperative part in the diet of the population in the rustic zones of Africa, Asia and the Middle East, with rare agricultural areas, high temperatures and small amount of precipitation. The camel delivers in the vicinity of 1000 and 2000 L of milk during the lactation period of 8 to 18 months, while the daily production of milk is in the vicinity of 3 and 10 L ((BREZOVEČKI *et. al*, 2015). Camel milk products in the world are popular due to increasing demand and are typically available in pharmacies.

Cow milk seems to be everywhere, and is regularly underestimated, however it has numerous essential medical advantages for people, including its ability capacity to help in weight reduction, assemble strong bones and teeth, support the immune system, reduce fat, protect the heart, prevent diabetes, eliminate inflammation, and help stimulate growth. There were variations in constituents of camel's milk than in cow's milk. The main difference between cows and camels milk lies in the different physicochemical characteristic of the individual components (El-Agamy, 2006).

Lyophilization(freeze drying) is a procedure in small amounts of a product will be frozen, then placed under vacuum. Through vacuum the frozen liquid sublimates and ice immediately changes to vapour, without to defrost. After that the water is removed closer and closer till the core of the product.The lyophilization process is considered as an excellent drying process for heat sensitive products Regardless of the advantages, it is notable that the process has been perceived as the most costly process for manufacturing a dehydrated product (Boss *et al*., 2004; Tsinontides*et al*., 2004; Carvalho*et al*., 2007; Rogers *et. al*., 2008). Hereby the structure of the product stays intact and that's why the dried product can absorb quickly after the process. Due to the vacuum the ice will evaporate immediately without turning in to water again, and this ensures that most of the taste, of the surface and of the supplements will remain in place ((Akers *et.al.,*1987). Reasonable parameters of process application enable us to obtain best quality products compared to products dried with customary techniques (Gaidhani*et.al*., 2015). The objectives of the present study were to produce freeze dried camel milk with acceptable color and flow ability and to compare the physicochemical and functional properties of freeze dried camel's milk and cow's milk powder..

Materials and methods

Materials

Raw camel's milk and cow's milk were supplied by Al Ain Dairy Company. In addition, commercial cow milk powder samples were bought from a local supermarket in Alain, United Arab Emirates to be used in the study.

The freeze –drying process

Hundred ml raw camel's milk were cow's milk, were placed in especially glass bottles for freeze-drying, then glass containers was placed in were the deep freezer under a temperature of -75 °C for 24 hours, then the glass bottles placed in a freeze-drying, under the temperature of (-50 °C to -75 °C), under vacuum, to obtain the Freeze-dried powder.

Determination of physicochemical properties

The physicochemical properties of camel milk were determined as follows: Water activities of freeze dried powders were determined using a water activity analyzer (Rotronic SW with hydrolyte VD sensor, Rotronic Instrument Corp., Huntington, NY). The flowability (Hausner ratio) is the ratio of un-tapped bulk density and tapped bulk density. Un-tapped bulk density was determined by sifting milk powder into a 100 ml cylinder and then weighing. Tapped bulk density was determined by reading the volume after tapping the cylinder 100 times (AOAC, 1990).

For determination of solubility (amount of a substance that can be dissolved in a given amount of solvent),10 g of whole milk powder was mixed with 100 ml of water at approx.. 24 °C in mixer at high speed for 90s.The milk then was left for 15 min. After which it was stirred with a spatula. 50ml was filled into a graduated 50 ml centrifuge glass. The glass was spun in a centrifuge for 5 min, the sediment free liquid was sucked off, the glass was filled up again with water and the content was stirred up. Then the glass was placed into the centrifuge and spun for 5 min after which the sediment was read. The sediment was expressed in ml and was termed insolubility index. It usually below 0.2 ml in powder from good quality milk dried in designed dryers.

Process yield was calculated as the relation between total solids content in the resulting powder and total solids content in the feed mixture. Hygroscopicity values (determined by moisture gain by 2 g of powder samples) were measured under saturation solution of Na_2SO_4. After 1 week, hygroscopic moisture was expressed as g of moisture per100 g dry solids (g/100g) to determine hygroscopicity.

Hygroscopicity (g/100g) = (Wf – Wi)X100)/(Wi X(100-moisture/100) Where: Wf = final weight . Wi = initial weight.

Colour determination

The color of different samples was measured using a colorimeter (Hunter lab).The results were expressed in the CIE L, a, b. which determined the degree of lightness, redness and yellowness characteristics of the various milk powder samples Where L = is an indication of lightness. A = is an indication of redness. B = is an indication of yellowness.

Table 1. Physicochemical properties of Freeze-dried camel milk (FDC), Freeze-dried cow's milk (FDW) and commercial milk (CDM).

Run No.	aw	Untapped bulk density	Tapped bulk density	Haunser ratio	Insolubility Index	Yield	Hygroco-picity
FDC 1	0.307	0.52	0.45	1.15	0.85	91.23	27.32
FDC 2	0.334	0.38	0.29	1..31	0.85	81.42	26.23
FDC 3	0.253	0.41	0.33	1.24	0.65	94.57	26.72
FDW1	0.148	0.38	0.31	1.22	0.45	90.24	22.81
FDW2	0.326	0.42	0.37	1.13	0.55	91.23	22.12
FDW3	0.301	0.45	0.35	1.28	0.25	92.5	24.13
CDM	0326	0.37	0.30	1.23	0.10	ND	18.23

Chemical analyses

The contents of moisture, ash, protein, total soluble solids, fat and titratable acidity were determined according to AOAC(2000) methods. The pH value was determined using a pH meter (model HANNA pH 211 micro processor) according to AOAC (2010)] method. The ascorbic acid (vitaminC) content was determined in spray dried milk powder samples according to the AOAC(2010).

RESULTS AND DISCUSSION

Physicochemical properties

Physicochemical properties of the various samples is presented in Table 1. The water activity (aw) of freeze-dried camel milk (FDC) and freeze-dried cow milk (FDW) ranged 0.253-0.307 and 0.148- 0.301, respectively. While aw of the commercial milk sample (CDM) was 0.326. It seems that the concentration, temperature, direction of feed and type of milk did not affect water activity of freeze dried samples but it gave different results for commercial sample.

Data in Table (1) show the untapped bulk density of different of freeze-dried camel's milk, freeze-dried cow milk and commercial dried milk. The Freeze drying produced powder with lighter un-tapped bulk density (0.38-0.52) as compared to commercial sample (0.37).These values were relatively lower than those tapped bulk density which ranged between 0.29-0.45 compared to that of commercial milk which was 0.30.

The hausner (flowability) ratio of freeze-dried camel's milk and freeze-dried cow's milk ranged 1.15-1.31 and 1.13-1.28, while the hausner ratio for the commercial milk was 1.23. All these values fall within the standard value for free powder flowing , indicating the efficiency of freeze drying of both camel milk and cow's milk of acceptable flowability as indicted by De Jong *et al*.(1999) who stated that A hausner ratio of 1 to 1.25 indication the powder had free flowing, hausner ratio of 1.25 to 1.4 indicate fairly free flowing powder, and powder with hausner ratios greater than 1.4 are cohesive and do not flow well.

The freeze–dried camel's milk powder had higher insolubility index (0.65-0.85) when compared with those of freeze-dried cow's milk (0.25-.055).The commercial had less insolubility index freeze-dried samples, this may be due to additions of some materials to facilitate the solubility.The degree extent to which milk powders are insoluble in water has generally been measured in the milk powder industry using an insolubility test (solubility index, SI), basically developed by the American Dry Milk Institute American Dry Milk Institute (1971) and adopted by the International Dairy Federation (2005). The yield (the actual amount of substance obtained during preparation of a substance) of freeze-dried camel milk and freeze-dried cow milk powder raged 81.42 -94.57 and 90.24-92.5, respectively.

Hygroscopicity is is the ability of a substance to attract water molecules from the surrounding environment through either absorption or adsorption (Sulieman 2014). The data in Table (1) show the hygroscopicity of different freeze-dried camel's milk, freeze-dried cow's milk and commercial milk. It was found that the hygoscopicity of different powder milk was not affected by type of milk.Never the less, the freeze-dried milk powder samples had more hygroscopicity (22.32 to 27.32) than that of the commercial sample (18.23), and also more than the range determined by Sulieman *et.al*.(2014) for spray-dried camel milk and cow milk powder (20.43 to 20.47).

Colour characteristics of freeze-dried milk powder

Generally many parameters are used in judging the colour of dried milk powder. These parameters include:

Table 2. Lightness of different milk powder samples

Run No	Lightness	Redness	Yellowness
FDC1	94.34	-2.28	11.09
FDC2	92.84	-0.73	10.75
FDC3	91.20	-2.36	12.98
FDW1	93.49	-0.10	15.20
FDW2	94.16	-0.14	13.42
FDW3	92.84	-0.10	14.21
CMD	94.45	-0.28	21.84

Table 3. Chemical composition of Freeze-dried camel milk (FDC), Freeze-dried cow's milk (FDW) and commercial milk (CDM).

Run no	Moisture%	Fat %	Protein%	Ash%	TitrableAcidity %
FDC1	3.00	21.25	25.30	7.78	0.162
FDC2	2.44	22.96	24.35	8.05	0.205
FDC3	2.64	22.46	23.54	7.46	0.191
FDW1	1.43	22.88	22.61	6.96	0.175
FDW2	1.87	23.18	26.28	5.94	0.173
FDW3	1.82	29.24	25.02	5.44	0.155
CMD	1.70	31.89	25.42	5.28	0.155

FDC:Freeze-dried Camel's milk, FDW: Freeze-dried cow's milk,CMD :commercial cow'ssamples.

i- L value which is an indication of lightness and blackness. If the l is 100 the color is white. If the l is 0 the color is black.
ii- A value is an indication of redness and greenness. If the a value is positive, it indicates redness, if a value is negative, it indicates greenness.
iii- B value is an indication of yellowness and blueness. If the B value is positive, it indicated yellowness, if B value is negative, it indicated blueness.

Data in Table 2 shows the colour characteristics of freeze-dried milk powder made from camel and cow's milk. The lightness ranged between 91.20 and 94.34 while the commercial sample had a value of 94.45. These results indicate that although slight changes observed in the various samples, however, the lightness of all samples were acceptable. As for the redness,freeze-dried samples from both types of milk had valuesranging between -0.1 and -2.28 so indicated greenness. The yellowness ranged between 10.75 and 12.98 for the freeze-dried camel milk, while the freeze-dried cow milk had relatively higher values (13.42-15.20) and the commercial milk which was 21.84. It has been stated that the drying temperature affect the yellowness, low temperature produced less yellowness in comparison to high temperature (Sulieman *et. al*., 2014).

The colour changes of freeze dried milk powders could be bought about by Millard reactions, lipid peroxidation, degradation of ascorbic acid or sugar-sugar caramelisation,as suggested by Davies and Labuza (1997) who attributed colour changes in milk powder to non-enzymatic browning reactions.

Chemical characteristics

It is realized that changing of environment significantly affects regular physiological function of both human and animals, so it was essential to analyze camel and cow milk powder on Sudanese environment. The chemical composition of freeze-dried camel's milk (FDC), freeze-dried cow milk (FDW) and commercial milk (CMD) is presented in Table (3). The moisture content of FDC (2.44 -3.0%) were relatively greater than those of FDW (1.43-1.87%), while the commercial milk had a moisture content of 1.7%. However, the fat content ranged between 21.88 and 29.24%, was not affected by concentration and type of milk, but it should be noted that cow milk naturally contains more fat than camel milk, and this explains the relatively higher fat contents of FDW when compared with those of FDC samples.

The protein contents of FDC of FDW ranged between 23.54-25.30% and 22.61-25.02%, respectively. However, protein content of CMD was 25.42%. The ash contents of the various freeze- dried samples ranged between 5.78and 8.05% which fall within the range of CMD which was 5.44%. Increase in the ash content of camel's milk was due to its large amount of minerals and vitamins, as compared with milk cow, therefore, FDC exceeded FDW samples in their ash contents. The titrable acidity (expressed as lactic acid%) of FDC of FDW ranged between 0.162-0.205% and 0.155-1.75%, respectively. However, the titrable acidity of CMD was 0.155%. Generally, the acidity of milk is affected by concentration and type of milk (Sulieman*et. al.,* 2014).

Changes in the composition of some constituents in freeze-dried milk can be clarified as a function of the freeze-dried process. These progressions harmonized with changes in moisture content (Kumar and Mishra, 2004).

CONCLUSION

Based on the results of the present study, it is concluded that freeze-drying of camel and cow's milk could be an efficient method for producing acceptable products with little changes in most nutrient compounds. The flowability of all camel's milk and cow's milk powder were within the recommended values 50°C thus promoting a fairly good flow.It is recommended to pack dried products is vacuum, in order to obtain products with better functional and physicochemical properties.

Further investigations are required to approve the possibilities of camel milk powder on an industrial scale and to encourage utilization of camel's milk powder as sustenance fixings in snacks, chocolates, ice cream, infant formulae.

REFERENCES

Aker, K. C. ; Robinson, C. W., 1987. Growth of *Candida utilis* on single- and multicomponent-sugar substrates and on waste banana pulp liquors for single-cell protein production. J. Appl. Microbiol. Biotech., 3 (3): 255–274.

American Dry Milk Institute, Determination of solubility index, in: Bulletin 916 (Revised), Standards for Grades of Dry Milks Including Methods of Analysis, American Dry Milk Institute Inc., Chicago, Illinois, USA, 1971, pp. 26–27.

AOAC 1990. Official Methods of Analysis of AOAC International, 16th ed., 3rd revision, Washington, DC, USA.

AOAC *(*2010*)* Official Methods of Analysis. 18th Edition, Revision 3, Association of Official Analytical Chemists, Washington DC.

AOAC. 2000. Official Methods of Analysis. 17th ed. Association of Official Analytical Chemists, Gaithersburg, MD, USA.

Boss, E. A., Filho, R. M., and de Toledo, E. C. V. (2004) Freeze drying process: real time model and optimization. *Chem. Eng. Process*. **43**, 1475-1485.

BREZOVEČKI A. *et al*.: Camel milk, *Mljekarstvo 65* (2), 81-90 (2015).

Carvalho, A. S., Silva, J., Ho, P., Teixeira, P., Malcata, F. X., and Gibbs, P. (2007) Relationship between solubility of freeze-dried skim milk and death of freeze-dried *Lactobacillus delbrueckii*ssp. *bulgaricus*during storage. *Milchwissenschaft***62**, 148-150.

Davies C.G.A., Labuza T.P., 1997. The Maillard reaction: application to confectionery products. Confectionery science. Pennsylvania: Penn State Univ. Press. 35-66

De Jong, F. , Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Gätje, C., Marencic, H. and Potel, P., 1999. Feeding in Domestic Vertebrates: From Structure to Behaviour. CABi publishing. Walingford, Oxfordshire, U.K.

El-Agamy, EI. Camel milk. In: Handbook of milk of non-bovine mammals. Park YW, Haenlein GF (Eds), Blackwell Publishing, Iowa, USA, 2006; 297-344.

Gaidhani K.A., Harwalkar M., Bhambere D., Pallavi S. P. (2015). Lyophilization/ Freeze-drying – A review. World Journal of Pharmaceutical Research Vol 4(8): 516-543.

http://animals.sandiegozoo.org/animals/camel

International Dairy Federation, Dried milk and dried milk products – determination of insolubility index, IDF Standard 129, Int. Dairy Fed., Brussels, Belgium, 2005.

Kenzhebulat S, Ermuhan B and Tleuov A (2000). Composition of camel milk and its use in the treatment of infectious diseases in human.In, Proceedings of the 2nd Camelid Conference on Agroeconomics of Camelid Farming, Almaty, Kazakhstan, September 8–12, 2000.AgroMerkur Publ. 101

Kumar, P. and Mishra, H. N. 2004. Yoghurt powder- a review of process technology storage and utilization. Food and Bioproducts Processing 82 (C2): 133–142

Mal G, Sena DS, Jain, VK and Sahani MS (2006).Therapeutic value of camel milk as a nutritional supplement for multiple drug resistant (MDR) tuberculosis patients. Israel Journal of Veterinary Medicine 61:88-91.

Rogers, S., Wu, W. D., Saunders, J., and Chen, X. D. (2008). Characteristics of milk powders produced by spray freeze drying. *Drying Technol.* **26**, 404-412.

Soliman, G. Z (2002). Comparison Of Chemical And Mineral Content Of Milk From Human, Cow, Buffalo, Camel And Goat In Egypt. The Egyptian Journal of Hospital Medicine Vol., 21: 116 – 130

Sulieman A.E. (2014). Spray Drying of Karkade (Hibiscus sabdariffa L.) Calyces and Evaluation of the Product.

International Journal of Food Engineering 2014; 10(1): 157–165.

Sulieman A.E., Elamin O.M., Elkhalifa E A. and Laley L. (2014). Comparison of Physicochemical Properties of Spray-dried Camel's Milk and Cow's Milk Powder. International Journal of Food Science and Nutrition Engineering 2014, 4(1): 15-19.

Tsinontides, S. C., Rajniak, P., Pham, D., Hunke, W. A., Placek, J., and Reynolds, S. D. (2004) Freeze drying-principles and practice for successful scale-up to manufacturing. Int. J. Pharm. 280, 1-16.

Yoganandi J., Mehta B.M., Wadhwani K. N., Aparnathi K.D. (2015).Evaluation and comparison of camel milk with cow milk and buffalo milk for gross composition. Journal of Camel Practice and Research 21(2):259-265 · September 2015