

Original Research Article

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Development of Spray Dried Milk Powder from Genotyped Umbalachery Cattle and its Proximate Analysis

K. Brindha^{1*} and R. Kalai Nila²

¹Department of Animal Biotechnology, Madras Veterinary College, Chennai - 600 007
Tamil Nadu Veterinary and Animal Sciences University, India

*Corresponding author

ABSTRACT

Keywords

A2A2 milk, Umbalachery, Whole milk powder, Spray dryer, Proximate analysis

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The present study was to develop spray dried milk powder from A2A2 milk of Umbalachery cattle. Spray dried milk powder was produced from A2A2 milk using a table top mini spray dryer by optimizing the processing parameters. Proximate analysis was carried out in the developed spray dried milk powder and compared with that of A1A2 milk. Moisture of the content of A2A2 and A1A2 whole milk powder was $3.63 \pm 0.56\%$ and $3.52 \pm 1.02\%$ respectively. It was found that the ash and protein content were higher in A2A2 whole milk powder ($5.60 \pm 0.20\%$, $27.79 \pm 0.98\%$, respectively) than in A1A2 whole milk powder ($5.25 \pm 0.06\%$, $26.19 \pm 0.41\%$ respectively). The lactose content of whole milk powder from A2A2 milk was significantly lower than that of A1A2 milk. In addition, mineral content in terms of calcium, phosphorous and iron and vitamin content in terms of Vitamin A, C and D were also analysed.

Introduction

Milk is a functional ingredient and good source of nutritional elements for the growth and maintenance of the human body. Of all the milk proteins, casein contributes to as much as 80% the proteins (Roginsky, 2003). It is thought that beta casein variant A1 plays a crucial role in the development of human diseases like heart disease, type 1 diabetes and sudden infant death syndrome as it yields

the bioactive peptide casomorphin 7 (Kostyra *et al.*, 2004). Genotyping results have shown that about 80% of Indian native cattle produces beta casein A2 type which is considered to be healthier than A1 milk.

Processing of spray dried milk powder from genotyped A2A2 milk from Umbalachery cattle is a value addition to increase the shelf life. Concentrating milk into powders favours reduction in costs for storage and

transportation and increased microbiological and chemical stability (Walstra *et al.*, 2006). Milk powder functionality is essential in many applications such as nutrition supplementation, browning and flavor development, water binding, emulsification, viscosity modification, and texture. These enrichments are achievable through spray drying.

Spray drying is a process in which immediate removal of moisture from a liquid takes place to yield a final product in one of the forms of powder, granule or agglomerate, depending upon the physical and chemical properties of the feed, the dryer design and operation. As the spray drying process influence the functional properties of the final product, the best conditions should be selected for the production of excellent milk powder (Patel *et al.*, 1999).

Proximate analysis is a quantitative analysis of the different constituents in a food sample, in this case, whole milk powder sample. Proximate analysis determines the quality and nutritive value of milk powder using internationally recognized procedures. Moisture, protein, fat, ash and carbohydrates are the important proximate analytes in whole milk powder. The choice of the technique to determine the proximate analysis will depend on the requirements of the situation and the availability of resources. Therefore an understanding of the proximate composition analysis that occur under storage conditions will be very useful to predict the behavior of milk powder during its end use (Gasmalla *et al.*, 2013).

Hence the present study was undertaken to produce spray dried whole milk powder from A2A2 cattle and compared its nutritive value by analyzing the proximate parameters with that of A1A2 whole milk powder.

Materials and Methods

Sample selection

Blood collected from Umbalachery cows in an organized farm were genotyped as belonging to A1A2 and A2A2 genotypes using Tetra ARMS PCR as per the procedure followed in our previous study (Kalai Nila *et al.*, 2018).

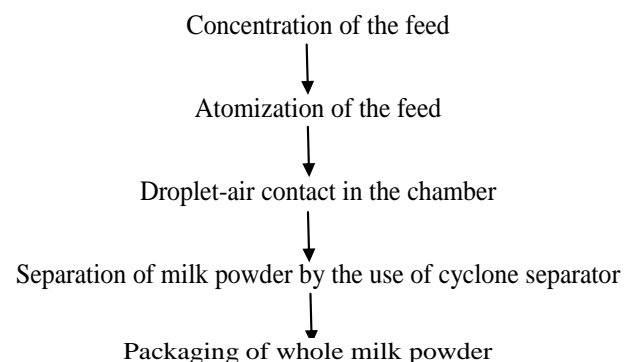
Experimental groups

The milk samples were collected from genotyped Umbalachery cows and categorized into two experimental groups namely A1A2 milk and A2A2 milk.

Optimization of spray drying parameters

Six replicates of pooled whole milk from A1A2 genotypes and A2A2 genotypes were dried using a table top mini spray dryer under co-current drying conditions. The parameters chosen for optimization of spray drying included inlet temperature, outlet temperature, size of the pressure nozzle, working pressure, speed of the blower, speed of the feed pump and feed temperature. The resulting spray dried whole milk powders obtained from A2A2 and A1A2 milk were stored at ambient temperature for proximate analysis studies.

Steps in spray drying methodology



Proximate analysis

The proximate composition of whole milk powder in terms of moisture, ash, fat, protein and lactose were determined following the procedure of AOAC (2000). Determination of the mineral content of the spray dried whole milk powder was carried out adopting ICP-OES method (1996) and High Performance Liquid chromatography (HPLC) for Vitamin A, C and D respectively.

Statistical analysis

Statistical analysis for comparison of the proximate composition of spray dried whole milk powder derived from A2A2 milk in terms of moisture, fat, protein, lactose and ash content in comparison with those of A1A2 milk was analyzed using unpaired t-Test at $p < 0.01$ and $p > 0.05$ using SAS package, 2014. Values for proximate analytes were expressed as mean \pm SE.

Results and Discussion

Yield of the spray dried whole milk powder

In the present study, a table top mini spray dryer of two litres capacity was used for production of whole milk powder A2A2 and A1A2 milk. The yield of spray dried milk powder in our study was 22.91 ± 0.76 grams per 300 ml of the feed, with an inlet air temperature of 160°C at a flow rate of 240 ml/h. Our yield is found to be better than that of Mujumdar (2008) wherein there was a significant decrease in the yield of milk powder with inlet air temperatures of 150°C and 160°C at feed rates of 350 ml/h to 420 ml/h.

Optimization of spray drying parameters Inlet temperature

Different air inlet temperatures from 130°C to 200°C were tried in our study. Emulsions

spray dried at 150°C inlet air temperature produced powders with significantly lower moisture content compared to those powders produced at 130°C and 140°C inlet air temperature (Goula and Adamopoulos, 2005). Thus it can be observed that optimal inlet air temperature of 160°C followed by us provided good driving force for removal of moisture from the product.

Outlet temperature

Patel (2009) observed that outlet air temperature was critical in the determination of the final moisture content of powder. In our study, an outlet air temperature of 65°C gave rise to whole milk powder with a moisture content of $3.63 \pm 0.56\%$. It was also reported that outlet air temperature of 60°C and 67°C was optimal to avoid the risk of discolorization of casein and impairment of its solubility. Hence, the outlet temperatures chosen ranged from 60°C and 67°C in our study.

Size of the pressure nozzle

The inner diameter of the nozzle used in our study was 0.5mm, 0.70mm and 0.90mm for the small, medium and large sizes respectively. Large nozzle gave rise to gritty textured milk powder, while small nozzle resulted in frequent clogging and hence required repeated cleaning of the spray dryer for future use. These issues were consistent with the observations of Gharsallaoui *et al.*, (2007). However we found that the medium sized pressure nozzle with 0.70mm diameter gave good results.

Working pressure

Although a range of operating pressures were suggested for pressure nozzles used in our laboratory model spray dryer from 5 psi to 150 psi, it was found that the ideal working pressure was 30psi which is equivalent to 2.1

kg/cm². This is very low when compared to the range of 250 psi working pressure suggested by Rivas (2009) for spray drying.

Speed of the blower

The amount of heated dry air entering the spray dryer can be increased or decreased by regulating the blower speed. As the blower speed setting has a significant effect on the drying performance of the device, we chose the medium speed of the blower suggested by Schuck *et al.*, (2008) from the available options namely low, medium and high.

It was found that a slight low pressure was ideal when the system was running in the sucking mode while medium speed was optimal for the spray drying process.

Speed of the feed pump

The manufacturer of our equipment had prescribed medium speed of the feed pump for whole milk powder production.

Hence medium speed for chosen for feeding of milk. Analogous observation made by Huang *et al.*, (2003) showed that the lower pump speed could not dry the product sufficiently enough resulting in sticky product and wet walls in the cylinder.

Feed temperature

Different feed temperatures were used our spray drying process ranging from 25°C, 40°C, 62°C and 71°C, as feed temperature influenced the properties of final product. As explained by Utikar *et al.*, (2010), use of low feed temperatures of 25°C and 40°C resulted in prolongation of time required for obtaining the finished product. It was found that optimal feed temperature of 71°C performed well during spray drying and resulted in dry whole milk powder with permissible moisture content of 3.63±0.56% and 3.52±1.02% for A2A2 and A1A2 whole milk powder respectively as shown in the Table 1.

Nozzle material

To prevent corrosion and abrasion, the nozzle material chosen was stainless steel. Stainless steel nozzles are often available, have excellent resistance to abrasion and good corrosion resistance for most feedstock as suggested by Huang *et al.*, (2001).

Proximate analysis of the spray dried whole milk powder

The mean values of gross composition of the spray dried whole milk powder from A2A2 and A1A2 genotyped milk were presented in Table 1.

Table.1 Statistical analysis of the proximate composition of A2A2 milk in comparison to A1A2 milk

Variables	A2A2		A1A2		t-Test	P - Value	Result
	Mean(X)	±SE(X)	Mean(Y)	±SE(Y)			
Ash	5.60	0.0660	5.25	0.0130	5.30	0.0003	**
fat	25.65	0.2823	24.22	0.8295	1.59	0.1437	NS
Moisture	3.63	0.1802	3.52	0.1873	0.41	0.6902	NS
Protein	27.79	0.3127	26.19	0.0751	4.99	0.0005	**
Lactose	37.27	0.6770	40.80	0.4252	4.39	0.0014	**

** - p<0.01
NS – p>0.05

Table.2 Comparison of the mineral composition of spray dried whole milk powder derived from A2A2 and A1/A2 milk

Milk type	Calcium (mg/100g) Mean±SE	Phosphorus (mg/100g) Mean±SE	Sodium (mg/100g) Mean±SE	Iron (mg/100g) Mean±SE
Spray dried whole milk powder from A2A2 milk	1058.56±1.04	840.08±1.15	222.88±1.11	0.14±0.03
Spray dried whole milk powder from A1/A2 milk	885.42±1.23	704.01±0.85	243.12±1.09	0.22±0.01

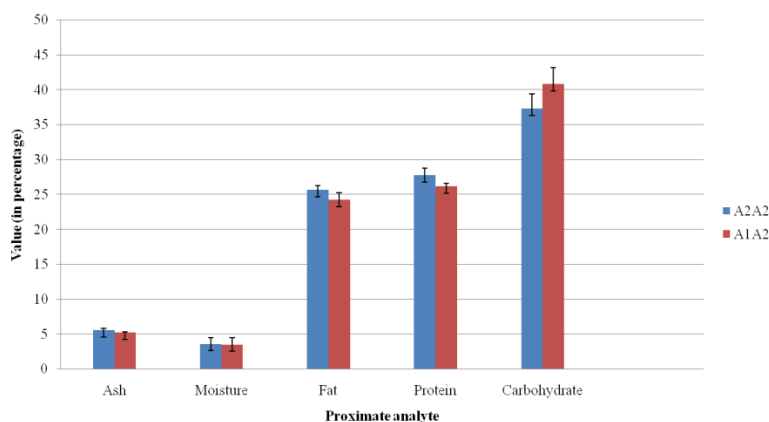
*Values are expressed as mg/100g of spray dried whole milk powder
Values are obtained from representative samples of six replicates

Table.3 Vitamin content of spray dried whole milk powder derived from A2A2 milk

Milk type	Vitamin A (µg/100g)	Vitamin C (mg/Kg)	Vitamin D (µg/100g)
A2A2 milk powder	57.26±0.58	0.50±0.007	0.37±0.009

*Values represent vitamin content in pooled whole milk powder

Comparative proximate analysis of A2A2 and A1/A2 milk of Umbalachery cows



The mean value of moisture content A2A2 and A1/A2 whole milk powder was found to be 3.63±0.56% and 3.52±1.02% respectively. This is in agreement with the 4% moisture suggested by BIS Standards (IS 11623, 2002), 5% moisture as in USDA Standards (2001), 5% moisture as in Codex Standards (207-1999). The values are in line with the nationally adopted FSSAI Standards (2011)

that recommend not more than 4% and 5% moisture content for whole milk powder and skim milk powder.

The mean values of other constituents like fat, protein, lactose and ash for A2A2 whole milk powder were 25.65±0.88%, 27.79±0.98%, 37.27±2.14% and 5.60±0.20%, whereas that of A1/A2 whole milk powder were

24.22±0.95%, 26.19±0.41, 40.80±2.32 and 5.25±0.06 respectively. The mean values of fat are in concurrence with the 26% fat content suggested by BIS Standards (IS 11721, 2002), 26.5% fat as in USDA Standards (2001), minimum of 26% fat as in Codex Standards (207-1999) and a minimum of 26% as in FSSAI Standards (2011). Though the fat levels in A2A2 and A1A2 milk of the tested Umbalachery cows did not differ significantly, Morris *et al.*, (2005) reported that carriers of the A2A2 genotype had significantly higher yield of milk fat over the A1A2 genotype in Holstein Fresian breeds.

Higher protein values in A2A2 genotype over A1A2 as obtained in this study may be directly correlated to the A2A2 genotype of the Umbalachery cows and is similar to the findings of Cardak (2005) in Simmentaler cows. Moreover, our protein values for A2A2 milk are found to be in agreement with the 28% protein content suggested by USDA Standards (2001), 27% protein as in Sudan Standards (2009), 27.2% as in Australian Standards (2010) and 24.5.0 to 27.0% as in Canadian Standards (2005). However, obtained protein values were lower than the recommendations of FSSAI Standards (2011) which requires not less than 34% protein content for whole milk powder and skim milk powder. Earlier Sulieman *et al.*, (2014) reported low protein content of 24.90% in their spray dried milk powder.

The lactose content of our A2A2 milk product is in line with the Australian Standards that recommend 38.3% lactose and Canadian Standards (2005) of 36.0 to 38.5% lactose. However, A2A2 milk is found to possess high lactose content when compared with the recommended 35.5% lactose content of USDA Standards (2001) and 34% of Sudan Standards (2009). The cause and effect relationship of high lactose content in A1A2 milk for the incidence of as against that in

A2A2 milktype 1 diabetes needs to be investigated.

The mean values of ash content in A2A2 and A1/A2 whole milk powder are within the recommended maximum of 7% ash by BIS Standards (IS 11623, 2002), 5.5 to 6.5% moisture of Canadian Standards (2005) and less than 6% as per USDA Standards (2001) in whole milk powder. In an earlier study, Khalidet *al.*, (2009) and Gasmalla *et al.*, (2013) had reported similar values of ash content in whole milk powder as 5.70±0.03% and 6.00±0.26% respectively.

Analysis of the mineral content of spray dried whole milk powder

The obtained values for mineral content of spray dried whole milk powders derived from A2A2 and A1/A2 milk of Umbalachery cows is given in Table 2.

The calcium and phosphorus content of A2A2 sample showed higher values of 1058.56±1.04 mg/100g and 840.08±1.15 mg/g of spray dried whole milk powder when compared to A1A2 sample with corresponding values of 885.42±1.23 mg/100g and 704.01±0.85mg/g respectively. Thus high calcium resources of A2A2 milk would be conducive in maintenance of skeletal and general growth requirements of 800mg/day for children and lactation and pregnancy requirements of 1200 mg/day (WHO Expert group, 2004). The abundance of phosphorus in A2A2 milk suggests that the recommendations for daily intake of phosphorus for children at 600-800mg/day and 600 mg/day for adults (WHO Expert group, 2004) could be partly met with milk which forms a primary diet of most Indian population.

The sodium and iron content of A2A2 sample with values of 222.88±1.11 mg/100g and 0.14±0.03 mg/100g of spray dried whole milk

powder were found to be lower than the corresponding values of 243.12 ± 1.09 mg/100g and 0.22 ± 0.01 mg/g respectively in A1A2 milk. However, Australian Standards (2010) suggest values as high as 310 mg/100g in whole milk powder. As per the WHO Expert group, the recommended daily intake of sodium is 589 - 1005 mg/day for children and 1902- 2092 mg/day for adults. In order to avoid iron deficiency, Australian Standards (2010) recommend 0.3 mg/100g in whole milk powder and Codex Standards (1999) sets a minimum iron content of 0.45 mg/100kcal in infant milk formulas. As anemia is a serious public health problem in India affecting all segments of the population (50-70%), the stipulated recommendations of daily intake of iron can be met by practicing iron fortification strategies in A2A2 milk products.

Vitamin content of spray dried whole milk powder

Quantification of Vitamin A, C and D in spray dried whole milk powder derived from A2A2 milk of umbalachery cows was performed by HPLC method. It was found that A2A2 milk samples contained 57.77 $\mu\text{g}/100\text{g}$ of vitamin A, 0.50 mg/kg of vitamin C and 0.375 $\mu\text{g}/100\text{g}$ of vitamin D (Table 3).

As WHO Expert group (2004) recommends daily intake of 500-600 $\mu\text{g}/\text{day}$ of vitamin A for adults and 4800 $\mu\text{g}/\text{day}$ of β carotene, infant milk formulas are now formulated to contain 590-740 $\mu\text{g}/100\text{g}$ of vitamin A content in them. The results of our analysis revealed $0.37 \pm 0.009 \mu\text{g}/100\text{g}$ of vitamin D in A2A2 spray dried whole milk powder. However, WHO Expert group (2004) recommends a daily intake of 5 $\mu\text{g}/\text{day}$ vitamin D for adults. The results of our analysis indicate a higher vitamin C content of $0.50 \pm 0.007 \text{mg}$ per kilogram of spray dried whole milk powder derived from A2A2 milk

of umbalachery cows. About 20 mg of vitamin C is reported to be present in one litre of milk (Schieberle, 2009).

In conclusion, milk from A2A2 genotyped Umbalachery cow was used to derive spray dried whole milk powder. Optimization of spray drying and comparison of the proximate analytes of whole milk powder derived from A2A2 milk and A1/A2 milk revealed that spray drying is a value addition technique to A2A2 milk that could result in derivation of healthy and nutritious safe milk product for human consumption.

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