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PRODUCTION OF SHEEP'S MILK POWDER BY SPRAY DRYING TECHNIQUE: PHYSICAL, MICROBIOLOGICAL AND SENSORY

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ABSTRACT

In this study, milk sheep was dried by spray dryer to produce milk of sheep powder for the purpose of extend the shelf-life and facilitate storage. The objective of this research was to determine the spray drying parameters, resulting in the conditions of injection nozzle of 3 mm in diameter, air flow of 30 m3 / h, pump flow 1.23 L / h, inlet temperature 160 ° C, pump air flow 2.66L / h and outlet temperature 80 ° C and 2% proportion of soy lecithin. Moisture content, fat content, protein, pH, water solubility, coagulase positive Staphylococcus , Bacillus cereus , coliforms at 45ºC and salmonella sp were analyzed for the powder samples. In order to assess sensory acceptability, sensory analysis of the product was carried out compared to similar products available on the market. The product presented favorable results and in accordance with the legislation in terms of physical, chemical and sensory requirements. Sensory analysis showed that the product under study has less acceptability when compared to cow's milk, however when compared with goat's milk there was no significant difference. The results indicate that the product can be produced on an industrial scale with some adjustments and in addition, the results found can serve as a basis for the elaboration of a specific legislation for milk and sheep products in Brazil.

Keywords: Milk, Sheep, spray drying

1 INTRODUCTION

Sheep farming in Brazil is an activity under development both for the production of meat and wool, as well as for the production of milk and dairy products. Currently, the country is the largest sheep milk producer in South America, whose production has been seen as a sustainable alternative, with low initial investment and easy adoption by family labor, which can improve the quality of life of small rural producers (Balke et al., 2015). With a production of 1.72 million liters of sheep milk in the country, the region s Northeast and South have 52.7% and 28% of the national herd respectively, currently the milk production is intended for cheese and yogurt (Embrapa, 2018)

Sheep 's milk differs from cow's milk especially in the richness of the constituents (fat, protein, lactose, vitamins and minerals) which are much higher than cow's milk, making some countries consider sheep's milk a delicacy. Although consumption in its fluid form is low, sheep's milk is transformed into cheese, yogurt and other derivatives, both products have a high commercial value and bring with them a wealth of nutrients (Balke et al., 2015; Balthazar et al., 2017). The proportion of fat and protein is higher in sheep's milk compared to cow's milk, which results in greater yield in the production of sheep's milk cheeses (Boudalia et al., 2020).

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According to Pellegrini, (2012) sheep's milk is indicated for people with lipid malabsorption syndromes, as they have a greater amount of short and medium chain fatty acids, which are more easily absorbed by these people and also by those with diseases related to digestion and absorption of nutrients. There are also studies that point to a lesser effect on cholesterol, the presence of higher levels of conjugated linoleic acid that is effective in combating cancer and important in reducing body fat. Nonetheless, there is still a gap in legislation and production information, technological aspects and characterization of sheep dairy products as well as a lag of alternative products, including powdered sheep milk, whose production does not happen in Brazil.

Spray drying is the common method used in the food industry for drying milk, its use is justified by the low cost in relation to other processes. The drying by spray drying is eight times more economical than freeze-drying and four times more economical than vacuum drying (Lee et al., 2018). The factors that have the greatest significance in the drying process are the inlet temperature between 120ºC - 180ºC, air flow inlet and the feed flow rate, these variables affect the physical properties of the powders, interfering in the yield, humidity, hygroscopicity, water activity, solubility, and density (Samsu & Zahir, 2020).

Powdered sheep's milk has low humidity and, with this, it can present additional advantages such as the reduction or inactivation of microorganisms and reduction of the physicochemical reactions responsible for the deterioration of the product. In addition, the production of milk powder appears as differential ease of transport, storage and handling of the final product, be it directly for consumption or as an ingredient in the preparation of other food products (Kilian et al., 2016).

Therefore, the effect of variable drying milk in sheep powder by spray using spray drying were unknown and need to be investigated. The physical, chemical, microbiological, and sensory properties of the product were determined in this work, considering that this product is not yet available in the dairy market.

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2 Material and methods

2.1 Sample preparation

Sheep milk was provided by Cabanha rural property from Chapecó, Santa Catarina State. After the milking process, the milk was stored under refrigeration in a cooling tank. Subsequently, the milk was subjected to pasteurization at a temperature of 63 ° C to 65 ° C for 30 minutes and immediately after cooling (Figure 1).

Figure 1 – Process for obtaining sheep's milk powder

Source: The author (2023)

The milk was subjected to concentration in a rotary evaporator (Fisatom 802®), in order to obtain a concentration of milk with 40% solids. Afterwards, the mixer with temperature adjustment (Vorwerk TM31®) was used at a temperature of 60ºC for 5 min. to carry out the incorporation of soy lecithin at a concentration of 2% to concentrated sheep's milk. The percentage ratio was determined as the amount of soy lecithin / total volume of sheep's milk multiplied by 100.

2.2 Spray drying procedure

The spray drying was performed in a laboratory dryer with atomization system in nozzles, spray dryer (Labmaq - LM - MSD 1.0®), according to Figure 2, with a 3 mm diameter injection nozzle, air flow of 30 m3/h. The drying variables of the concentrated sheep's milk at a temperature of 40°C were: inlet temperature 160°C, pump flow rate 1.23 L/h, pressure 2.66 bar and outlet temperature 80°C.

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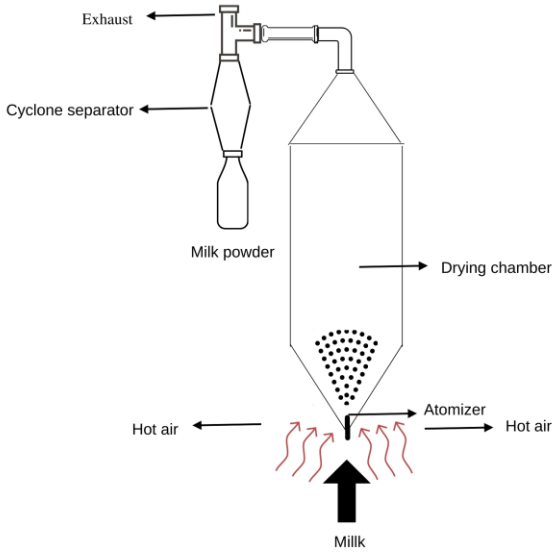
Figure 2 – Process for obtaining sheep's milk powder



Source: The author (2023)

2.3 Analysis of sheep milk powder

The finished product was characterized in terms of its physical, chemical, microbiological, and sensory properties. The analyzes were performed in duplicates in the study laboratories of the SENAI/SC University Center, UniSENAI–Campus Chapecó/SC.

2.3.1 Chemical Physics Analysis

Analyzes of moisture content (%), fat content (%), protein (%) index and hydrogen potential (pH) were described using the methodology of the Adolfo Lutz Institute (2008). In addition to these, a solubility analysis was carried out, which was carried out using the method of IN 68, of December 12, 2006. Which has the official Physical-Chemical Analytical Methods for controlling milk and dairy products.

2.3.2 Microbiological analysis

The microbiological parameters evaluated were: *Bacillus cereus* (UFCg- 1), Coliforms at 45 ° C (UFCg- 1), *Staphylococcus* coagulase positive (UFCg- 1) and *Salmonella* sp. To carry out the

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analyzes, we followed the methodologies ISO 7932: 2004, AFNOR 3M 01/2 - 09/89 C, ISO 6888 - 1: / Amd 1: 2003 and ISO 6579-1: 2017 respectively. The results obtained from the microbiological analyzes were compared with the microbiological parameters for food established by Resolution RDC nº 12/01 of Anvisa (BRASIL, 2001) and evaluated as satisfactory or unsatisfactory based on the tolerance limits established by the same.

2.3.3 Sensory Analysis

The project was initially submitted to the ethics committee of the University of Unochapecó for evaluation and assessment under number 39286420.7.0000.0116. The opinion was favorable, obtaining the Certificate of Presentation for Ethical Appreciation (CAAE) granted under number 4.426.578. Sensory analysis was carried out by trained testers and qualified for the descriptive profile method, in which attributes of color, flavor, appearance, aroma, and presence of defects in powdered milk of three different species were evaluated: sheep, goat and cow.

3 Results and discussion

3.1 Physical Chemical Characterization

Sheep powder after drying and characterized presented favorable characteristics for commercialization and consumption, as shown in Table 1. The physical and chemical assessment is necessary to monitor the quality of the milk and check for possible degradation problems.

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Table 1 - Results of physico-chemical analyzes of sheep 's milk powder

Parameter analyzed	Result
Humidity (%)	5.51 ± 0.13
Lipids (%)	37.85 ± 0.0433
Protein (%)	31.71 ± 0.05
Solubility (mL / 24 ° C)	1 , 0 ± 0.0
pH	6.70 ± 0.07

* Results are expressed as the mean and standard deviation.

Source: The author (2023)

According to Normative Instruction N°. 53 of October 1, 2018 (MAPA) which deals with the standard of identity and quality of powdered milk, the humidity is slightly at odds with the legislation because it exceeded the value established in the normative instruction, which is a maximum of 5 % of humidity for whole milk powder, the value of lipids, proteins and other aspects found are within the established in legislation for whole milk powder cow, taking into account that there is no specific legislation for milk in sheep powder. One must also consider the experimental character on a laboratory scale applied to the milk drying process, which can be improved on an industrial scale in order to adjust the moisture content. Once the moisture content (which can be reduced) is adequate, the solid constituents such as fat and protein will have their fractions increased.

Lopez et al., (2019) determined the protein content in sheep's milk powder samples and obtained concentrations that varied between 30.8 and 32.1 g / 100g of sample. The milk, produced in Italy, was obtained from animals fed a diet enriched with sources of selenium, such as olive leaves, in order to increase the levels of this in milk, which leads to the conclusion that feeding the herd considerably affects the composition of the milk. The race or presence of certain genotypes affects the fraction and amino acid composition of the protein in sheep's milk (Albenzio et al., 2016). The composition of fresh sheep's milk varies according to the lactation stage, parity, season, ambient

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temperature, lactation and milking efficiency, age and animal nutrition, genetic factors (species and breed), and udder diseases (Balthazar et al., 2017).

3.2 Results Microbiological analysis

The results of microbiological analyzes of sheep's milk powder can be seen in Table 2.

Table 2 - Results and tolerance standards used for the microorganisms analyzed

Essay	Result	Limit*	Method
Bacillus cereus (UFC / g)	3, 4X10²	5x10³	ISO 7218: 2007
Coliforms at 45 ° C (UFC / g)	<1.0x10	< 10	AOAC 986.33
Coagulase-positive *Staphylococcus* (CFU / g)	< 1.0x10	< 10²	ISO 7218: 2007
Salmonella sp.	Absence / 25g	Absence / 25g	ISO 6579-1: 2017

*Limit of acceptable tolerance by legislation.

Source: The author (2023)

The Microbiological analyzes performed are in accordance with what is recommended in RDC 12 of 2001, (ANVISA). This result indicates the product has undergone proper handling, being safe for human consumption. Ferreira et al., (2017) when analyzing samples of fermented and non-fermented acidophilic milk, found satisfactory results for the analysis of total coliforms, thermotolerant and filamentous fungi. Liu et al., 2018, when analyzing the detection of *Bacillus cereus sensu lato* in environments associated with production facilities for infant formula made from goat's milk, obtained 36.1% of samples were positive. Showing that the manipulation environment is responsible for part of this contamination, requiring a stricter control. Microbiological analyzes are important to release the product for human consumption, as it must be safe.

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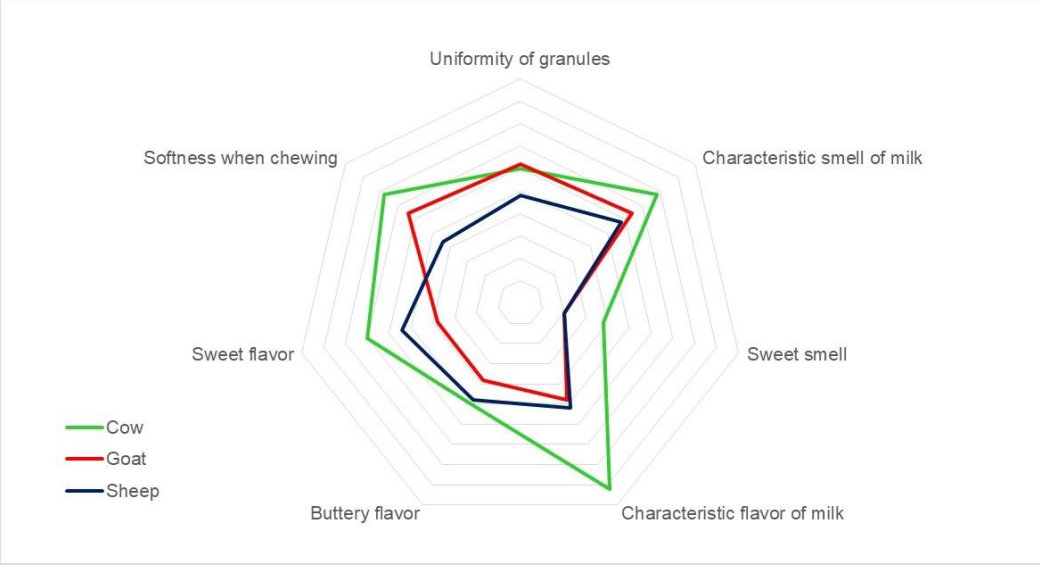
3.3 Sensory evaluation

Sensory differences were observed when comparing sheep milk with bovine milk, a result that was already expected considering that consumers are used to consuming cow's milk powder. The biggest difference found was in the undesirable sensations, where sheep milk presented issues such as greater adhesiveness and a sensation of crystallization (Figure 3). However, when compared to goat milk, sheep milk was at the same level in practically all parameters. Regarding color, it is observed that there is no tendency for sheep milk, while goat milk is whiter in color, and cow's milk was evaluated as being more yellowish.

Figure 3 – Result of sensory evaluation of sheep milk powder compared to two commercial brands (cow and goat)



Source: The author (2023)

The integral type sheep milk powder had good acceptance second evaluators in the specified attributes. It is a product that matches the powdered goat milk already available on the market.

Products to the sheep's milk are scarce in the market and are not easily accessible to the general population. Research on sensory acceptance and development of new products, as well as

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characterization of these are underway, although there are still few bibliographies available as well. In order to characterize frozen yogurt made with different formulations and based on sheep's milk, researchers obtained scores ranging from 5.24 to 7.06 for the overall evaluation of the product (de Abreu et al., 2018). This score is consistent with that obtained in the sensory evaluation of the global analysis of powdered milk, which averaged 8.03. Gajo et al., (2012) evaluated sensory acceptance of standard minas cheese made with sheep's milk and obtained a global acceptance index between 6.3 and 6.7 as well. In general, whenever compared to cow's milk or cow's milk derivatives, products of ovine origin are described as I liked it moderately on the hedonic scale. The affinity with the cow's milk that has milder flavor characteristics is the main factor that leads to a lower acceptance of sheep's milk, whose rich nutrient composition also affects the intensity flavor, smell and body milk. The results found for the physical-chemical, microbiological and sensory characterization of powdered milk are compatible with the values found in the literature and legislation of bovine milk, thus obtaining a viable product with great acceptance.

4 CONCLUSIONS

The milk sheep powder was obtained by spray drying technique dryer were evaluated chemical, microbiological and sensorial the developed product. The powder showed favorable characteristics when an inlet temperature of 160 ° C was used, so spray drying is an alternative to add value to sheep's milk, increasing its durability thus facilitating transport. The physical, chemical and sensory characteristics were shown to be favorable when compared with the cow's milk legislation, showing that the product is safe for human consumption. In addition, the study can serve as a basis for the elaboration of specific legislation for the production of sheep's milk powder. The evaluation of the sensory attributes of sheep's milk powder in this study is comparable to commercial goat's milk powder, available on the market. In the global assessment, acceptance was moderately liked, leading to a prospect of good acceptance by the consumer, which can be produced on an industrial scale.

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