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Overall Evaluation of Produced Flavored Low Lactose Milk Powder for Lactose Intolerants

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Abstract

One of the ways that can prevent lactose intolerant refuge to use dairy products is generation of new products which is easily accessible.

In this study, flavored (banana, cocoa) low-lactose milk powder, flavored (banana and cocoa) milk powder, low-lactose milk powder and milk powder were produced using a co-current spray dryer. The inlet and outlet temperature was 145°C and 75°C, respectively.

Moisture, fat and lactose of treatments were measured and carbohydrates were compared also. Samples which treated with enzyme (lactase, 0.15%) are bare of harmful carbohydrate for lactose intolerant and they can reconstitute this powder for using and benefit the nutritional matters of milk without any side effects.

After reconstituting of samples, sensory evaluation was investigated. Investigations revealed that flavored low-lactose milk accepted as a new product that doesn't have disadvantages of low-lactose milk because of its sweetness taste and flavored milk because of adding sugar (6-7%).

Keywords: lactose, milk powder, flavored, sensory evaluation

1. Introduction

Dairy products play an important role in human food but the large population suffering from lactose intolerance problem which making them unable to consume milk and milk-based products. Therefore, it must be the focus of more studies to produce omnifarious dairy products to conquest this problem (Di Stefano et al., 2002; Pai, 2008 & Shaukat et al., 2010).

A study of more than 1000 adults with symptoms of lactose intolerance found that they were most receptive to information about hydrolyzed-lactose milk that communicated multiple benefits, such as nutrition and tastelactose-free milk is real milk just without the lactose that tastes great and provides the same essential nutrients as regular milk including calcium, potassium, vitamin D and more (Hourigan, 1984).

It has been stated that customers who are lactose intolerant or believe they are, will pay a big premium for the right product (Prescott, 2012).

Valio, the leading dairy manufacturer in Finland, (Valio, 2013b) produce a lactose-free milk powder that can be used in confectionery, dairy, bakery, ready meals and other applications.

The market for lactose-reduced and lactose-free dairy products has undoubtedly risen in recent years. This has been reflected in the development of technologies to reduce and remove the lactose from dairy. The hydrolysis of lactose using lactase of various sources has been well adopted in the dairy industry. Europe is a worldwide leader in the lactose-free market. Sales of lactose-free products are expected to increase 75% between 2012 and 2016 reaching €529M by the end of this period (Prescott, 2012; Valio, 2013a).

A report by Mintel (Jago, 2011) suggested that the UK is currently not a big player in the dairy sector of new product development (accounting for 3% of European dairy NPD) and with 15% of the UK population avoiding dairy in their diet, and 12% avoiding lactose, there is opportunity to generate big sales in the industry.

This work aims at producing flavored (banana and cocoa) hydrolyzed-lactose milk powder with spray dryer and

evaluating the chemical and sensory aspects of them.

2. Materials and Methods

2.1 Milk

Pasteurized milk supplied from a local dairy company in north of Iran with 1.5% fat.

2.2 Low Lactose Milk

Hydrolysis of lactose was done with lactase enzyme (Lactozym 3000 L HP G, novozymes, Denmark) by the rate of 0.15% and 37 °C incubation temperature. For deactivation of enzyme, pasteurization of hydrolyzed milk was performed.

2.3 Flavored Low Lactose Milk

Hydrolyzed milk was divided in two parts and then flavoring ingredients was added, separately. The rate of cocoa powder (ELCAFE, Turkey) and banana concentrate (Chiquita brands, Inc. Malaysia) was 0.7% and 5%, respectively.

2.4 Flavored Milk

Plain milk was divided in two parts and then flavoring ingredients was added, separately. The rate of cocoa powder (ELCAFE, Turkey) and banana concentrate (Chiquita brands, Inc. Malaysia) was 0.7% and 5%, respectively.

2.5 Powder Production

All the materials mentioned in above sections fed separately into a co-current spray dryer (Behsozan Co., Iran) which inlet and outlet temperature was 145°C and 75°C, respectively. The powders (table 1) were collected and after reaching to ambient temperature kept in amber-colored glass flasks for analysis.

Table 1. Nomination of powders

Powder	Nomination
Milk powder	MP
Low lactose milk powder	LLMP
Flavored (banana) low lactose milk powder	F(B)LLMP
Flavored (cocoa) low lactose milk powder	F(C)LLMP
Flavored (banana) milk powder	F(B)MP
Flavored (cocoa) milk powder	F(C)MP

2.6 Chemical Analysis

Lactose analysis was determined using Lactostar analyzer (Lactostar, Labortechnik 12105 berlin, Article No. 3510, Germany). Other carbohydrates were determined using enzyme test kits (R-Biopharm, Darmstadt, Germany) and Gas Chromatography Mass (Agilent 7000A, USA).

Fat content was determined using Gerber method (ISIRI 2012). The moisture content of the produced powders was determines by the oven drying method at 103 ±2 °C (ISIRI 2012).

2.7 Sensory Evaluation

Sensory evaluation was performed for reconstituted flavored low lactose milk with 30 untrained panelists. They scored the samples in according to the forms which received. In that form, color, odor and taste of the reconstituted powders investigated by the 5-point hedonic scale (5-extremely like, 4-like, 3-neither like nor dislike, 2-dislike, 1-extremely dislike). (Lawless and Hymann, 1998). Samples were poured in glass containers with digital codes. Each panelist received 100 ml of reconstituted flavored (banana) low lactose milk, reconstituted flavored (cocoa) low lactose milk, reconstituted flavored (banana) milk and reconstituted flavored (cocoa) milk, reconstituted milk and reconstituted low lactose milk. Each panelist evaluated all the samples for each parameter. Water consumed between testing.

2.8 Statistical Analysis

Analysis of variance was calculated using the standard ANOVA procedure. Significant differences between the means were estimated using Duncan's multiple range tests. Significant differences were determined at $\alpha = 0.05$ level of significance.

3. Results and Discussion

Low lactose milk was produced with lactase enzyme (Hatami, et al., 2010). In initial experiments, between three temperatures of 37 °C, 41 °C and 45 °C and two time of 3 and 4 hour, optimum activity of enzyme was at 37 °C and 3.20 hr. The remaining lactose in milk incubated at 37 °C for 3.20 hour was 12% of initial content (Figure 1).

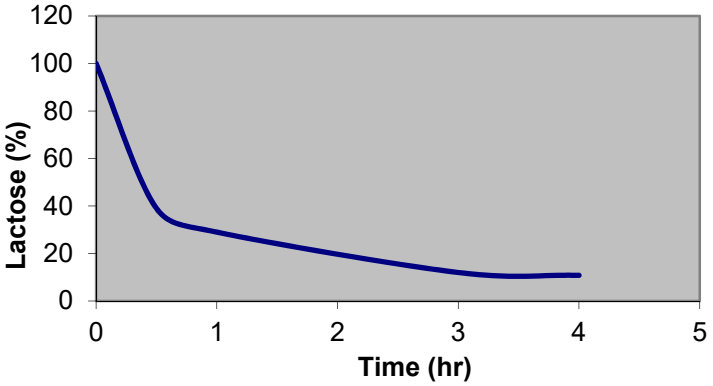

Figure 1. Remaining lactose content during the time course of reaction at 37 °C

Ruiz-Matute et al., 2012 denoted that during the manufacture of lactose-free UHT milks, galactosoligosaccharides (GOS) can be formed from transglycosylation reactions. GOS are prebiotics, defined as 'non-digestible food ingredients that beneficially affect the host by stimulating growth of bacteria in the colon that can improve health'. A study by Ruiz-Matute, *et al.,* (2012) found that the GOS formation reached a maximum of 10,000mg/L (20% of total carbohydrates) when 75 to 90% of lactose was hydrolyzed and gradually decreased to values below 5000mg/L when over 99% of the lactose was hydrolyzed. According to their data, milk with a GOS content of 7800mg/L can be obtained when the residual lactose content is 2% of total carbohydrates. This GOS content would be enough to exert a beneficial health effect on consumers, concluding that the functional properties of low-lactose milk can be improved by controlling the final stages of the enzymatic hydrolysis of lactose.

Different spray drying temperatures were used; 145, 155, 165 and 175 °C but finally, experiments were performed at 145 °C. The outlet temperature was fixed at 75 °C. The dimensions of spray dryer air heating system were 30 cm diameter and 50 cm height with 5 elements as electric air heaters. The ambient air is filtered, heated and introduced into the drying chamber. Air cleaning is performed by dry filters. The dimensions of spray dryer cyclone were 35 cm diameter and 70 cm height.

There was no powder stickiness on the chamber wall surface. In spray drying, stickiness occurs when particles are insufficiently dry collide with one another or with the dryer walls and become stuck.

Chemical analysis of six treatments was performed and results indicated in tables 2.

Table 2. Chemical characteristics of six treatments of milk powder

	characteristics		
Treatments	**Moisture (%)**	**Lactose (%)**	**Fat (%)**
MP	2.25±0.1	48.12±0.35	15.1±0.2
LLMP	2.2±0.23	4.8±0.25	15.3±0.14
F(B)LLMP	2.3±0.21	5.3±0.12	15.1±0.18
F(C)LLMP	2.6±0.24	4.6±0.10	15.2±0.14
F(B)MP	2.4±0.15	47.8±0.22	15.2±0.2
F(C)MP	2.3±0.17	47.5±0.34	15.3±0.17

Moisture content of produced powders in this study was below the critical level (5%) according to Iran national standard. These powders have low moisture and fat contents and when stored in dry, cool conditions, have a shelf life in excess of two years. Milk powders absorb moisture very readily from the atmosphere, and if packed

in materials which are not impermeable to moisture, it may develop large hard lumps or severe caking during storage.

Masters, 1991 and Pisecky, 1997, showed that the moisture content of a dairy powder is related to the outlet air temperature, the moisture content decreasing when the outlet air temperature increases.

As it demonstrated in table 1, the lactose content of produced low lactose powders is lower than common milk powder. The lactose content of the milk has been fully preserved when the milk is dried and turned into powder. However, unlike powdered milk which can stay fresh for a long period of time at room temperature, the bacteria present in whole milk that has not been pasteurized will convert the lactose present in milk into lactic acid gradually, making the milk sour.

As F(B)LLMP, F(C)LLMP and plain LLMP contain low amount of lactose, it can be concluded that with reconstituting of these powder with water, it doesn't have any side effect on lactose intolerance people. Reconstituting of produced powder was performed and carbohydrates were determined. Fig 2, compares the percentage carbohydrates of reconstituted powders.

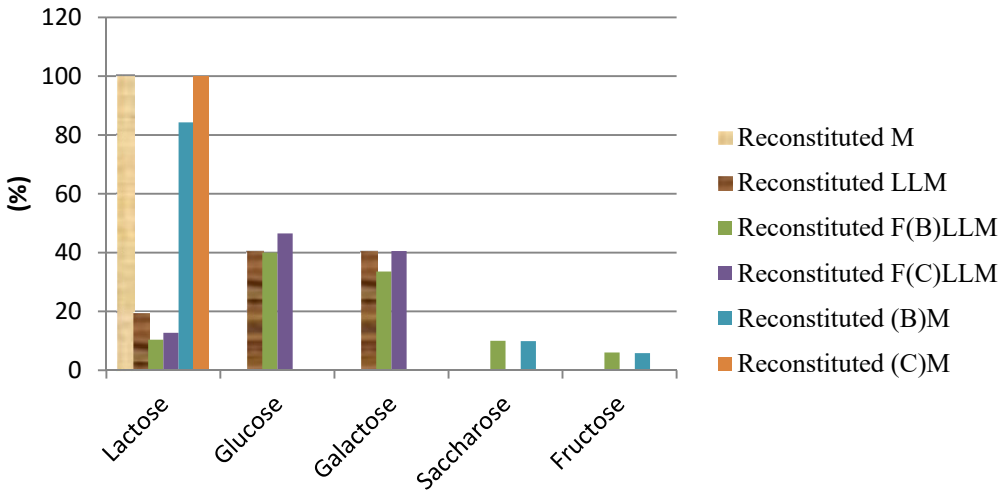

Figure 2. Carbohydrates (**%**) of reconstituted powders

Reconstituted F(B)LLM, F(C)LLM and plain LLM are bare of harmful sugars for lactose intolerance people and consumption of these products is suitable for lactose intolerant.

The sensory scores of all these treatments were performed and results shown in table 3.

Table 3. Taste, color and odor evaluation of treatments

	Scores of sensory evaluation (out of 5)		
Treatments	**color**	**taste**	**odor**
Reconstituted M	$5^{a} \pm 0.0$	$4.60^{a} \pm 0.2$	$4.9^{a} \pm 0.0$
Reconstituted LLM	$4.8^{a} \pm 0.2$	$4.1^{b} \pm 0.1$	$4.8^{a} \pm 0.1$
Reconstituted F(B)LLM	$4.87^{a} \pm 0.4$	$4.67^{a} \pm 0.2$	$5^{a} \pm 0.03$
Reconstituted F(C)LLM	$5^{a} \pm 0.0$	$4.2^{b} \pm 0.3$	$5^{a} \pm 0.0$
Reconstituted F(B)M	$4.85^{a} \pm 0.0$	$4.2^{b} \pm 0.1$	$5^{a} \pm 0.0$
Reconstituted F(C)M	$5^{a} \pm 0.0$	$3.5^{c} \pm 0.1$	$5^{a} \pm 0.0$

Means in the same column with the same superscript are not significantly different ($p<0.05$)

As is clear from the data in table 2, there is no significant difference between the mean values of scores in treatments as a color and odor point of view ($p>0.05$). But, the significance level of the test as a taste point of view, is smaller than 0.05 and there is significant difference between the mean values of scores in samples. The

highest score for taste was recorded for reconstituted F(B)LLM. Reconstituted LLM don't prefer because of its sweet taste but combined it with flavoring agent is pleasant.

Choi et al., 2007 recorded that since the mixture of glucose and galactose is sweeter than lactose, lactose-hydrolyzed milk is not popular because of sweetness and off-flavor.

As the taste score of reconstituted F(C) LLM was lower than F (B) LLM, a treatment with F(C) LLM and 2% sugar prepared and then sensory evaluation was down again. This time the satisfactory increased to 85% (data was not shown). Sensory evaluation revealed that the treatments; reconstituted F (B) LLM and reconstituted F(C) LLM with 2% sugar were well appreciated by the panelists for taste, color and odor. All these studies illustrated that production of flavored low lactose milk powder is a good way to introduce new generation of products for lactose intolerance people. It can be say that application of enzyme for producing low lactose milk and then mixing with other flavoring matters followed by drying with spray dryer is a successful way for creating different kinds of flavored low lactose milk powders. These are products that lactose intolerance people can use them by reconstituting by water at any time without using refrigerator.

These powders can be packed in a bag which is storable for a long term without alteration and will be consume without alimentary tract problems. These produced powders can consume by everybody in every place and every time. Packaging of powders in sachet is a persuasive status which people especially children and adult like to consume these products (Hatami, 2011).

As flavored milk is the most popular milk choice among school children and accounts for 66% of all milk sold in schools according to a recent report based on the U.S. Department of Agriculture's *School Nutrition Dietary Assessment Studies I and III* (28, 62), strategy of making this type of products can be a good option for lactose intolerant to benefit all essential nutrients of milk and meet current daily dairy food and calcium intake recommendations.

Next to the medical aspect of lactose intolerance, some very important technological advantages result from the lactose hydrolysis into glucose and galactose. For example, the solubility increases from 18 to 55% (w/v) at 80% conversion and the sweetness rises up to 70% related to sucrose. Thus, the production of self-sweetening products or products with less sucrose addition would be possible by using lactose hydrolyzed milk (Zadow, 1992).

Applying this strategy can be part of an eating plan that supports healthy life. It is possible to produce milk products with normal taste and high nutritional protein quality for lactose intolerant people around the world. Flavored milk can help close the gap because children prefer it and will drink more milk when it's flavored. These products have general consumption and not only lactose intolerant but also all consumers can use these products and profit the nutritional advantages of them.

The removal of nearly all the water content of flavored low lactose milk yields a compact, concentrated product which is easily transported and stored. It may be stored for very long periods and reconstituted again in water when required. Produced powders have the ability of packaging in sachet and have long storage life without needing of refrigerator.

Transportation costs can be reduced when shipping this product to distant markets. With the presence of modern technologies, this research gives many advantages to food industry and human life.

4. Conclusion

In conclusion, flavored low lactose milk powder with acceptable sensory attributes like odor, color and taste could be produced with blending of low lactose milk and flavoring agents followed by drying with spray drying. When lactose is hydrolyzed, the resulting glucose and galactose increase the sweetness of the product. Glucose is much sweeter than lactose. This is desirable in some products like flavored low lactose milk powder. Nutrient-rich flavored milk comes in a variety of flavors and offers the same unique nutrient package of nine essential nutrients as unflavored milk. Offering flavored low lactose milk powder is an excellent way to increase milk consumption among children and make their diets more nutritious and can help people especially lactose intolerant meet their calcium requirements.

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