Formulation of β-Glucan fortified milk beverage and its sensory acceptability

Smita Singh and Rajendra Kumar Pandey

Abstract
Milk is regarded as complete food, as it contains all the essential nutrients. But the market still lacks good flavored and fortified milk beverages that have led an increase in the consumption of carbonated drinks. β-Glucan is a soluble dietary fibre that imposes several health benefits because of its gel-forming ability and imparting viscosity to the meals. It helps in regulation of appetite and gives a feeling of satiety. This study was done to evaluate the processing methods to maximize the stability and sensory acceptability of β-Glucan in β-Glucan fortified milk beverage.

Keywords: β-Glucan, stability, heating process, maltodextrin, sensory acceptability

1. Introduction
Milk plays an important role in human nutrition by providing all the essential ingredients required for the metabolism of the human body system. The average composition of milk is water 87.20%, protein 3.50%, fat 3.70%, lactose 4.90% and ash 0.70% (Byron et al., 1974) [1]. Milk is also good source of minerals such as, calcium, phosphorus, and fat-soluble vitamins (A, D, E and K) (Kajal et al., 2016) [6]. Milk is the base for the preparation of all the dairy products (Okenova et al., 2010) [12]. When milk is either fortified or enriched, it could complete the nutritional requirements of the people (Krupa et al., 2011) [7]. Especially, cow milk posses multiple benefits along with its nutritional value (Mendelson, 2011) [10]. β-Glucan is structural polysaccharide found abundantly in the cell wall of endosperm and aleurone layers of oat, barley, wheat and rye (Charles and Louise, 2005; Lazaridou et al., 2008) [5, 9]. It is naturally present in the cereal grains and fungal mass and possess biological response modifiers that are physiologically active compounds (Vetvicka and Vetvickova, 2017) [14]. β-Glucans are heterogenous group made up of D-glucose monomers linked by glycosidic bond, i.e. (1-3)-β, (1-4)-β or (1-6) β (Stier et al., 2014) [17]. β-Glucans are also conferred as water-soluble polysaccharides or, popularly recommended by scientists as viscous polysaccharides, i.e. non-digestible polysaccharides. Being a soluble dietary fibre, it has gained tremendous attraction towards its incorporation in food products. The health benefit of β-Glucan lies in the fact that it increases the viscosity when mixed with liquids (Rebello et al., 2014) [19] and makes a gel-like structure. This property of β-Glucan has been positively associated in the prevention of many health-related severe diseases like, cancer, cardiovascular disease, lowering of glycemic index, diabetes, obesity and hypertension (Jirdehi et al., 2013) [5]. It has also been reported that β-Glucan helps in the regulation of appetite, i.e. increased stomach distension, gastric emptying and delayed intestinal transit (Kristensen and Jensen, 2011) [16]. Moreover, the increased viscosity of the intestinal content delays the absorption rate of nutrients as well as increases the transit time (Malijaars et al., 2008) [11].

The fortification of β-Glucan in milk is quiet difficult in milk due to the consequence of phase-separation. To avoid this difficulty, potential dairy stabilizers could be used such as, κ-carragenan, Maltodextrin, gum Arabic, gum acacia; etc. or a combination of any of these. Maltodextrin is a simple carbohydrate that is easily digestible and gets converted to instant energy (Parikh et al., 2014) [13]. It is being used extensively in food and dairy industries due to its emulsifying, texturizing, stabilizing, gelling and non-crystallizing properties. Fortified, or functional beverages are becoming a part of the healthy lifestyle for the people all around the world; but fibre enriched milk beverage is still lacking in the market. Incorporation of dietary fibres is being done on a large scale into drinks, juices and smoothies. There is still lack of research about incorporating dietary fibre into milk beverages. Therefore, this research was planned to study the fortification of β-Glucan and its stability in the milk beverage along with its sensory acceptability.

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2. Materials and Methods
The present work was carried out in the laboratory of Department of Animal Husbandry & Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. β-Glucan fortified milk beverage was manufactured using cow milk, β-Glucan, Maltodextrin, sugar and vanillin powder.

2.1 Collection of raw materials
Cow milk was procured from the Dairy Farm of the Department of A.H. & Dairying, IAS, BHU. β-Glucan was procured from Kuber Impex Ltd., Indore. Sugar was purchased from the local market of Varanasi. Maltodextrin was obtained from the laboratory. Vanillin powder was procured from International Flavors and Fragrances, New Delhi.

2.2 Preparation of fortified milk beverage
The fortification of β-Glucan in milk was made using two processing methods, i.e. single stage heating method (Fig.1) and two-stage heating method (Fig.2) (Bangari, 2011.) The level of all the ingredients was selected on the basis of preliminary trials. For 100 ml of cow milk, sugar was 4%, Maltodextrin 7%, vanillin powder 1.0% and β-Glucan 3.0% (Chatterjee and Patel, 2016).

2.3 Storage of β-Glucan fortified milk beverage
β-Glucan fortified milk beverage was hot filled in glass bottles and stored at 4 °C and 7 °C for a period of 60 days that was analysed at a time interval of ten days.

2.4 Sensory acceptability of β-Glucan fortified milk beverage
The sensory analysis of β-Glucan fortified milk beverage was carried out at 4 °C and 7 °C by a semi-trained panel of 9 judges including the members from staff and students of the Department of Animal Husbandry & Dairying at Banaras Hindu University, Varanasi, India (Rathor et al., 2016). The judges were asked to review the samples as acceptable or non-acceptable on the basis of physical appearance and mouthfeel.

3. Result and Discussion
3.1 Comparison of the heating protocols
The single-stage heating method, i.e. simultaneous addition of all the ingredients showed less stability to β-Glucan as compared with the two-stage heating method. This is because in single-stage heating method the complete hydration of maltodextrin did not take place with milk and lead to the phase-separation. At the end of 40th day, phase separation was completely observed in the sample stored at 7 °C; whereas for the sample stored at 4 °C, phase separation was observed at the end of 60th day (Table 1).

In case of two-stage heating method, i.e. separate addition of the ingredients, the samples showed stability till the end of the 60th day (Table 2). This is because the separate addition of maltodextrin allowed its complete hydration in milk which further stabilized β-Glucan. This result is in agreement with
the findings of Bangari (2011) and Chatterjee and Patel (2016) who also observed the same result with the use of β-glucan.

3.2 Sensory acceptability of the fortified milk beverage
The sensory acceptability of β-Glucan fortified milk beverage was evaluated on the basis of physical appearance and overall acceptability. Table 1 & 2 depicts the data for sensory acceptability of β-Glucan fortified milk beverage made with two processing protocols and stored at 4ºC and 7ºC. Milk beverage made by simultaneous addition of ingredients was found to lose its acceptability by the end of 40th day for the sample stored at 4 ºC; whereas the acceptability decreased after 30th day for the sample stored at 7ºC (Table 1). Off-flavor of β-Glucan was sensed which highly decreased its acceptability. Milk beverage made by separate addition of ingredients remained acceptable till the end of 60th day (Table 2). No off-flavor due to β-Glucan was felt upon consumption. Similar results were also found by Bangari (2011) that separate addition of ingredients in the formulation of milk beverage gave more consumer acceptability as compared with the simultaneously added ingredients procedure.

Table 1: Sensory acceptability of β-Glucan fortified milk beverage made by single-stage heating process

<table>
<thead>
<tr>
<th>Days</th>
<th>Sensory Acceptability</th>
<th>4ºC</th>
<th>Acceptable/Non-acceptable</th>
<th>7ºC</th>
<th>Acceptable/Non-acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Completely Liquid, No phase separation</td>
<td>Acceptable</td>
<td>Completely Liquid, No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>Slightly separation observed</td>
<td>Still acceptable</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>Two separated layers as well as off-flavor observed</td>
<td>Rejected</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Slightly separation observed</td>
<td>Acceptable</td>
<td>Sample discarded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Two separated layers observed</td>
<td>Not acceptable, Rejected</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Sensory acceptability of β-Glucan fortified milk beverage made by two-stage heating process

<table>
<thead>
<tr>
<th>Days</th>
<th>Sensory Acceptability</th>
<th>4ºC</th>
<th>Acceptable/Non-acceptable</th>
<th>7ºC</th>
<th>Acceptable/Non-acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Completely Liquid, No phase separation</td>
<td>Acceptable</td>
<td>Completely Liquid, No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td>No phase separation</td>
<td>Acceptable</td>
<td></td>
</tr>
</tbody>
</table>

4. Conclusion
Therefore, it is concluded that the two-stage heating regime could be effectively used to make the stability of β-Glucan with the addition of Maltodextrin in milk. The fortified milk beverage could be preserved for 60 days without any phase separation.

5. References
14. Rathor KY, Singh S, Kumar S, Pandey KR. Optimization and storage study of Banana chocolate. International...

