Production of Drinking Powder Containing Soy Milk Powder and Low Calorie Sweeteners

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ABSTRACT
In recent decades, consuming low calorie foods containing sugar substitutes has enhanced to reduce energy intake, decline of blood sugar and body weight control. By increasing tendency to reduce food energy intake through consuming lower sucrose foods and increasing demand for healthy, functional and nutritious soft drinks in the shape of ready to drink beverages, squash and drinking powder; in this study, by removing sugar from some usual drinking powders and replacing it with three other sweeteners, Stevia rebaudioside-A, erythritol and isomalt, five formulations of a drinking powder containing different combinations of the three sweeteners along with soymilk powder and apple-juice powder were evaluated. In the samples, 80 percent of the required sweetness was coming from Stevia, and remaining 20 percent of the sweetness from 5 ratios of Erythritol: Isomalt (100:0, 75:25, 50:50, 25:75, 0:100). In all five samples, there was a constant measure of soymilk powder and apple-juice powder. The samples examined in terms of physicochemical and organoleptic characteristics. Results showed that all samples were physicochemically in standard range and they had acceptable organoleptic quality, but the one with a 75:25 erythritol-isomalt ratio was more desirable.

INTRODUCTION
More than one million people are over weighted or fat over the world. Obesity increases the risk of cardiovascular diseases, diabetes and different types of cancers. High expenses are spent for treatment of these diseases since the importance to prevent and to control these diseases can be realized. So regulating diets and reducing gained calories through decreasing sucrose and substituting it with other sugars is a necessity which cause producing appropriate products for fat and diabetic people [3].

Beverage is a common term for a big group of foodstuffs which are consumed in liquid form [7]. Beverages dedicated significant rate of health promoter products to themselves. In other words, 33 to 73 percent of functional foods are formed as beverages [6]. In last decades, consuming drinking powders were prevalence in the world and it divides into two major groups: sweetened drinking powder containing particular percent of sweeteners and other powders without sucrose or with low level of sweetness, which needs sweeteners in addition to water during consumption [9].

Soy milk traditionally gained from water/protein extract from soaked and grinded soybeans and so it contains more compounds of soybean. Despite high nutrition value of soybean and high protein of it, soybean union in America was reported that flavor is the first reason for limiting the soybean products consumption in daily diet. Soy milk and other soy beverages have properties like bean and chalky flavor. Hence, changing formulation to improve the total flavor of soy beverages is essential for its consumption. Soy beverages mixed with other juices are the new generation of soy products and are an appropriate way to increase the soy protein in diets. Selling soy beverages is doubled since year 2000 and fruity soy beverages own a large market by selling over 100 million dollars [12]. Recent research shows that the blend of fruit juice and soy beverage has a valuable bioaccessibility and contains the important nutrients [14].

Soy milk powder is water extraction of soybean, which contains more than 38 percent protein and 90 percent dry matter. Soy milk powder has many Isoflavones compounds, and the level depends on the production process. This product can be used in many formulations like ice cream, cheese and milk powder [12].
Sugar alternative sweeteners are sugar substitute additives, which make more sweetness in food products and making lower energy of sugars. Indiscriminate use of each sweetener can cause medical problems. One way to decrease the probable danger of these sweeteners is to use these sweeteners together and use the synergistic effects of them on flavor and taste properties simultaneously. By substituting strong sweeteners with sugar in different formulations, the texture of products is changed because of different flavors of these sweeteners. It is needed to use sweeteners and bulking agents in new formulation to modify and improve product texture [17].

Stevia is a common name for stevioside and rebaudioside A. Stevioside and Rebaudioside A are sweet glycoside steviol extracted from leaf of Stevia rebaudiana Bertoni plant and are non-nutritive herbal sweeteners, which can be an appropriate alternative for sugar or artificial sweeteners. These sweeteners were approved by FAO and WHO in 2005; they also gained GRAS approval from FDA [1]. Diterpene glycosides are compounds which are known as the major agent of sweet test in stevia herbal extracts. Their sweetness is estimated about 300 times sweeter than sugar. Only stevioside and rebaudioside-A are considered among all extracted sweet glycosides economically and scientifically. Rebaudioside-A are more polarized and soluble; so they have more similar taste to sugar than stevioside. This has made their taste more desirable and mild. Purified rebaudioside has liqueur and bitter taste so its usage in beverages without calorie is not desirable. This limitation can be solved by combining rebaudioside-A to nutritional and other non-nutritive sweeteners [10, 13]. On the other hand, using Stevia sweeteners which contains 97% rebaudiosid, in a mango nectar, did not show any off-flavor in sensory tests [4].

Erythritol is a four carbonate alcoholic sugar, which has a mild sweet taste and an appearance similar to sugar. It can be used as a non-calorie, bulking sweetener in controlling weight because it cannot be metabolized and ferment in large intestine. It has 70% sweet of the sugar and can improve the sweet quality of the other strong sweeteners [11].

Isomalt is one of the other low calorie sugar alcohols, which are used as bulking sweeteners in non-sweet products. Isomalt is the only bulking sweeteners gained from sugar and is as useful as sugar. Its sweetness is pure, mild and without any undesirable test. The evaluation has shown that mixture of isomalt with other strong sweeteners makes the sweet test similar to sugar. Sweeting power of isomalt is 45-60% of sugar. But using isomalt along other volumetric sweeteners like other sugar alcohol makes the sweet taste intensive. Isomalt is alcohol disaccharide and should be converted to its monomer for absorption; it is also low metabolism in body [11, 15]. Due to no metabolism and limit absorption of isomalt in body, it makes lower energy than other sweeteners which metabolize completely [15].

MATERIALS AND METHODS

1 - Materials:
Soymilk powder was prepared from Soysun Company, apple juice powder from agent of Kanegrade Company in England, rebauside A from Sweden pure circle, erythritol and isomalt from Chinese BAOILINGBAO BIOLOGY Company, modified cornstarch named N-creamer 110 from agent of national starch Company and hydrolyzed sunflower lecithin with high HLB index and silicon compounds as anti-foam and citrate compounds as anticaking with Lecisol commercial name were prepared from Spanish Lasenor Company. Also maleic acid was prepared from a Chinese Company and natural apple powder flavor was purchased from Etol Company of Slovenia.

2- Sample preparation:
Each serving size of beverage is designed such that 40 grams of drinking powder solve in in 260 milliliter water and contains 6.25 grams soy protein and 20% natural juice. 80% of sugar sweetness with stevia rebauside-A was equivalent as major sweetener and bulking agent low calorie including erythritol and isomalt. As 80 percent of sugar sweetness was prepared from Stevia, and remaining 20 percent of the sweetness was prepared from 5 ratios of Erythritol to Isomalt (100: 0, 75:25, 50:50, 25, 75, and 0:100). The treatments are shown in Table 1.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Erythritol : Isomalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 : 0</td>
</tr>
<tr>
<td>2</td>
<td>75 : 25</td>
</tr>
<tr>
<td>3</td>
<td>50 : 50</td>
</tr>
<tr>
<td>4</td>
<td>25 : 75</td>
</tr>
<tr>
<td>5</td>
<td>0 : 100</td>
</tr>
</tbody>
</table>

3- Physicochemical tests:
pH, acidity, total soluble solids, humidity, ash, protein, total sugar and fat were measured according to AOAC method [2]. Calorie level was calculated through follow relation:
Calorie = (protein percentage*4) + (fat percentage*9) + (carbohydrate percentage *4) + (amount of sugar alcohol*7)

4- Sensory evaluation:

Sensory evaluation was done for qualifications including color, smell, taste, tissue and flavor, sweetness level, sweet test and total acceptance through 5 point hedonic test; 40 grams of each sample was added to 360 mL water separately and mixed. Then samples were poured into similar tannish glasses and were cooled to 15 °C. These samples were coded randomly with three-digit codes and were given to 5 evaluators familiar with soymilk who were trained primarily. To change palate of evaluators, they were given water among samples. Score 1 is the least quality score and 5 is the highest quality score [16].

5- Statistical analysis:

Experiments were performed in triplicate. The data were analyzed using One-way Analysis of Variance (ANOVA) and Duncan test by SPSS 18.0.

Results:

The results of the physicochemical properties are shown in Table 2. In 80% level of stevia, the effect of Erythritol: isomalt ratio to pack weight is significant (p<0.05). Sample 5 with ratio of (0:100) Erythritol: isomalt had the maximum weight which was significant different (p<0.05) from samples 1 (100:0), 2 (75:25) and 3 (50:50). Moreover, the protein level of sample 5 (0:100) is significantly lower than 4 other samples (p<0.05). Also, the effect of ratio of Erythritol: Isomalt on fat is significant and sample 1 (100:0) is significantly (p<0.05) more than samples 2 (75:25), 4 (25:75) and 5 (0:100). In 80 percent of stevia, samples 4 and 5 had the highest amount of sugar and were significantly different from samples 1, 2 and 3 (p<0.05). Sample 3 had significant difference with sample 1 which had the least average level of sugar (100:0).

The results of sensory evaluation are shown in Table 3. In all 80% levels, there is no significant different among color, smell, taste, tissue, and sweetness level and sweet test properties of samples. In 80% of stevia, the effect of ratio Erythritol: Isomalt on overall acceptance was significant (p<0.05). Sample 2 had the most acceptance and was significantly different from sample 5 (p<0.05).

<table>
<thead>
<tr>
<th>Sample 5</th>
<th>Sample 4</th>
<th>Sample 3</th>
<th>Sample 2</th>
<th>Sample 1</th>
<th>Sample Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.45 ±0.212*</td>
<td>41.43 ±0.657**</td>
<td>40.68 ±0.957*</td>
<td>40.54 ±0.788*</td>
<td>40.07 ±0.845*</td>
<td>Weight</td>
</tr>
<tr>
<td>14.19 ±0.609*</td>
<td>15.03 ±0.134*</td>
<td>15.02 ±0.808*</td>
<td>15.37 ±0.264*</td>
<td>15.62 ± 0.310*</td>
<td>Protein</td>
</tr>
<tr>
<td>7.97 ±0.493*</td>
<td>8.23 ± 0.404*</td>
<td>7.90 ±0.103*</td>
<td>8.60 ± 0.100*</td>
<td>8.67 ± 0.115*</td>
<td>Fat</td>
</tr>
<tr>
<td>3.03 ±0.152*</td>
<td>41.84 ±0.990*</td>
<td>39.98 ± 1.25*</td>
<td>38.82 ±0.502*</td>
<td>38.26 ± 0.139*</td>
<td>Sugar</td>
</tr>
<tr>
<td>2.90 ±0.100*</td>
<td>3.03 ±0.967*</td>
<td>3.27 ±0.461*</td>
<td>3.23 ±0.493*</td>
<td>3.33 ± 0.493*</td>
<td>Ash</td>
</tr>
<tr>
<td>4.01 ±0.422*</td>
<td>4.82 ±0.190*</td>
<td>4.48 ±0.129*</td>
<td>4.76 ±0.380*</td>
<td>3.98 ± 0.331*</td>
<td>Humidity</td>
</tr>
<tr>
<td>95.99 ±0.422*</td>
<td>95.25 ±0.132*</td>
<td>95.49±0.185*</td>
<td>95.24 ±0.385*</td>
<td>96.02 ±0.331*</td>
<td>Total dissolved solids</td>
</tr>
<tr>
<td>7.00 ± 0.000*</td>
<td>7.01 ± 0.115*</td>
<td>7.20 ±0.000*</td>
<td>7.20 ± 0.000*</td>
<td>7.13 ± 0.577*</td>
<td>Brix</td>
</tr>
<tr>
<td>5.24 ±0.103*</td>
<td>5.59 ±0.2412*</td>
<td>6.09 ±0.606*</td>
<td>6.05 ±0.650*</td>
<td>5.78 ± 0.626*</td>
<td>Acidity</td>
</tr>
<tr>
<td>4.01 ±0.537*</td>
<td>4.05 ±0.100*</td>
<td>4.04 ±0.152*</td>
<td>3.94 ±0.100*</td>
<td>3.96 ± 0.152*</td>
<td>pH</td>
</tr>
<tr>
<td>343.46±1.471*</td>
<td>338.59±7.635*</td>
<td>317.10±2.740*</td>
<td>309.16 ±0.669*</td>
<td>297.51 ± 2.157*</td>
<td>Energy</td>
</tr>
</tbody>
</table>

Table 3: Organoleptic properties of drinking powder samples (Mean ± standard deviation)

<table>
<thead>
<tr>
<th>Sample 5</th>
<th>Sample 4</th>
<th>Sample 3</th>
<th>Sample 2</th>
<th>Sample 1</th>
<th>Sample Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.20 ± 0.837*</td>
<td>2.95 ± 0.875*</td>
<td>3.32 ±0.856*</td>
<td>3.17 ±0.894*</td>
<td>3.25 ±0.837*</td>
<td>Color</td>
</tr>
<tr>
<td>2.56 ± 0.595*</td>
<td>2.71 ±0.804*</td>
<td>2.61 ±0.548*</td>
<td>2.39 ±0.723*</td>
<td>2.60 ±0.548*</td>
<td>Smell</td>
</tr>
<tr>
<td>3.45 ± 0.894*</td>
<td>2.42 ± 0.720*</td>
<td>3.40 ±0.894*</td>
<td>3.60 ±0.548*</td>
<td>3.58 ±0.548*</td>
<td>Flavor</td>
</tr>
<tr>
<td>2.40 ± 0.548*</td>
<td>2.80 ±0.837*</td>
<td>3.00 ±0.707*</td>
<td>3.05 ±0.710*</td>
<td>3.00 ±0.707*</td>
<td>Taste</td>
</tr>
<tr>
<td>3.43 ±0.548*</td>
<td>3.63 ±0.548*</td>
<td>3.20 ±0.447*</td>
<td>3.80 ±0.837*</td>
<td>3.22 ±0.488*</td>
<td>Sweetness level</td>
</tr>
<tr>
<td>3.00 ± 1.225*</td>
<td>3.60 ±0.548*</td>
<td>3.60 ±0.548*</td>
<td>3.80 ±0.837*</td>
<td>3.80 ±0.837*</td>
<td>Sweet test</td>
</tr>
<tr>
<td>2.80 ± 0.837*</td>
<td>2.60 ±0.548*</td>
<td>3.60 ±0.548*</td>
<td>3.80 ±0.448*</td>
<td>3.40 ±0.548*</td>
<td>Total acceptance</td>
</tr>
</tbody>
</table>

Discussion:

1-Physicochemical characteristics:

As it is shown in Table 1, samples weight was about 40 grams. In this study, protein of samples was evaluated through macro-kjeldahl method. In this method, proteins can be measured regardless structure. Samples are designed in such a way that they contain 6.25 grams protein and so the soymilk powder is
considered constant in all samples. But as it was predicted, the measured amount of protein was lower than expectations in some samples and the weight of each package was lower than 40 grams. So sample proteins got higher than 6.25 grams; protein percentage decreased due to the higher weight percent of sweetener compounds and constant level of milk powder in formulation. Similar interpretation is applied for fat level, ash, total dissolved solids and acidity of samples.

Evaluating the sugar level of five drinking powder samples shows that the sugar level is lower in these samples compared with drink powder standards. This is due to not use of sugar as sweetener in formulation and its sweetness is more than total sugar in soymilk powder which is 30 grams in each 100 grams on average (as there is no edited standard for soy powdered milk, this amount was compared with that of Soysun Company).

It is obvious that in a food, humidity level and total solids are supplementary. According to drinking powder standards, the maximum allowed level of humidity is 1% [8]. But in this study, produced samples are in range of 3.98-4.82 % humidity which is because of using soymilk powder with 4-5 % humidity in formulation. Significant differences of humidity and total solids in some samples are due to weight change and amount of soymilk powder and sweetener compounds.

According to drinking powder standards, the amount of total dissolved solids should have 9 Brix at least [8]. This amount for soymilk is based on total solids, 5.5 percent minimum in beverage [9]. Research findings are not in standard range of drinking powder Brix. Despite high amount of solids in 100 milliliter prepared beverages (about 12% of total solids, this amount was calculated regarding total dissolved solids drink powder amount and estimating it in 100 mL beverages), Brix of five investigated drinking powders is in 7.00-7.13 range as the major ingredients of these samples are soymilk powder and apple juice that contain amounts of soluble and insoluble fiber. Perhaps, this amount of fiber causes decrease in total dissolved solids compared with predictions. Also, by evaluating weight data, total dissolved solids and protein, it can be concluded that samples with lower weights and higher proteins have more total dissolved solids. Investigating the results of acidity and pH level shows that these two factors are in determined range of fast drinking powder national standards.

In researches done by some researchers, pH of soy powdered milk samples- blueberry juice stand in 3.64-3.97 range and acidity stand in 0.54-0.86 range [12].

In all drinking powder samples, energy of each 100 grams of proteins is increased by increasing isomalt level and decreasing erythritol since the inability of Erythritol to produce energy. Erythritol is from those sugar alcohols which is not metabolized in human body and doesn’t produce energy [5].

2- Organelleptic characteristics:

Based on the scores of the sensory evaluators to color, smell, taste, tissue and flavor properties, it was seen that there is not significant difference among drinking powder samples and all treatments gained higher score than acceptable limit means 2.5. All samples had yellowish cream color and were yellower than natural color of plain soymilk due to yellow color of apple juice natural powder in these samples. Although sweetness of samples gained average to high score and there was no significant difference among samples, 3 of evaluators believed that the sweetness level is a little high and the beverage would be more desirable if the sweetness was lower. This can be due to the synergistic effect of erythritol and stevia which was reported by researchers similarly [5]. Totally, all 5 drinking powder formulation gained average score but the sample containing 75% erythritol and 25% isomalt gained higher acceptance score.

Conclusion:

All beverages containing soymilk powder, natural apple juice, stevia, erythritol and isomalt have higher amount of proteins. Also, each serving of this beverage (300 mL) contains 119.004-137.384 Kcal and sample 5 which just had isomalt in its formulation has the highest energy content and can be consumed as an appropriate snack. Sensory properties of these drinking powders were average or good score; sample containing 75:25 ratio of erythritol to isomalt gained the highest score of overall acceptability.

REFERENCES


