Effect of sucrose replacement on physicochemical parameters and sensory characteristics of instant coffee drinks

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Abstract. Coffee is one of the most popular drinks in the world. There has been a trend in consumer behaviour over the last few years - a change in the traditional way of consuming coffee. Instant coffee drinks of the "3 in 1" type, which consumers prefer because of the convenience of consumption, are gaining more and more popularity. One of the main ingredients in the composition of this type of drinks is sugar. Its partial or complete replacement with suitable alternatives leads to a change in the sensory profile of instant coffee drinks and the overall perception by consumers. The aim of the present study is to evaluate the influence of isomalt as a sugar substitute in the composition of instant coffee drinks of the type "3 in 1" on their sensory profile and some of their physico-chemical parameters. Results show that isomalt is a suitable substitute for sugar in the composition of instant coffee drinks.

1 Introduction

Coffee is one of the most appreciated and popular drinks in the world due to its unique sensory properties such as aroma and taste. Coffee consumption increases from year to year [1]. Based on the data from the International Coffee Organisation (ICO, 2023) world coffee exports amounted to 10.24 million bags in November 2022, compared with 9.38 million in November 2021.

Coffee is traded in various forms, i.e., green coffee beans, roasted coffee beans, ground coffee or powder coffee, extracted coffee, instant coffee, dipped coffee, and ready-to-drink coffee [2].

Instant coffee powder drinks have the potential to be developed because they are popular with the community, there's no residue (no pulp in coffee), it has also a long shelf life, and it is easily soluble in water compared to ground coffee [3]. Instant coffee, also called soluble coffee or coffee powder, is a beverage obtained from the dehydration of roasted coffee extract [4]. Instant coffee can be presented to the consumer as a powder or granulate. Instant coffee is commercially prepared by either freeze-drying or spray drying technology, after which it can be rehydrated before consumption [5]. According to the Indian Institute of Food Processing Technology, instant coffee is divided into the following three groups: Non-agglomerated instant coffee powder, Agglomerated instant coffee powder and Granulated instant coffee powder.

In recent decades, significant changes in people's diet and lifestyle have been identified, which significantly contribute to the emergence of an epidemic of non-communicable diseases. Regardless of the important role of genetic factors, unhealthy nutrition, together with physical inactivity, have been identified as main factors in the development of non-infectious diseases such as obesity, diabetes, cardiovascular diseases, osteoporosis, etc. The main reason for overweight and subsequent obesity is the consumption of food and drinks, which, in terms of quantity and quality, bring energy into the body much more than the individual's energy expenditure [6].

Coffee consumption has been characterized as safe for adults in the general population, with a daily consumption up to 400 mg (equals to 5 cups of coffee). This constatation was given by European Food Safety Authority [7].

On this occasion, foods and drinks with sugar are defined as risky [8]. One of the main ingredient in the production of instant drinks of the "3 in 1" type is sucrose. This explains the increased consumer demand for low-calorie and "no added sugar" drinks [9].

Polyols (which are classified as sugar substitutes) find the greatest application in this direction. Currently, according to the food legislation in our country and in Europe, the polyols allowed for use in the food and beverage industry are sorbitol, mannitol, isomalt, maltitol, lactitol, xylitol and erythritol [10]. Polyols have less sweetness than sucrose and naturally exist in some sources and often are produced by hydrogenation of other sweeteners [11]. Polyols have the appropriate technical and functional properties in making food products and drinks [9].

One of the most preferred sugar substitutes from this group is isomalt. The combination of isomalt with the strong sweetener makes the resulting sweet taste of final product more similar to the sugar. Isomalt sweetener potential is about 45–60% of sugar [12].

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The aim of the present study is to establish the possibilities of obtaining instant coffee drinks of the type "3 in 1" with sugar, isomalt and stevia and its influence, as an alternative to sugar, on some of its indicators and the sensory profile of the obtained drinks.

2 Materials and methods

Three samples with different sweetener (sugar, isomalt and stevia), obtained under manufactured conditions was analysed in this study: 1) first sample contain sucrose, coffee, dehydrated glucose syrup, dry milk, vegetable oil and additives for the food industry). This sample was coded as SUS; 2) second sample with the same composition, but in which sugar was replaced with a combination of isomalt and stevia – STS.

The choice of the third sample was made in order to perform a better comparative characterization of instant coffee drinks. The third sample “3 in 1” is one of the best-selling coffee drinks in the segment [13]. It was purchased from the commercial network, coded as CLS, and it was used as a control sample. Fig. 1 shows the appearance of the analysed samples.

![Sample SUS](image1)
![Sample STS](image2)
![Sample CLS](image3)

**Fig. 1.** Appearance of the analysed samples

The moisture content was determined by moisture analyzer „Kern“ DLB 160-3A (Germany).

The kinetics of moistening of instant coffee drinks at a relative humidity of φ=68% was monitored. To maintain constant relative humidity at temperature \( t=20\pm2 \, ^\circ\text{C} \), a saturated solution of CuCl\(_2\) was used [14].

Total sugar and reducing substances contents were determined according [15].

The pH value was determined on 10% solutions of the instant coffee drinks samples using a pH meter "Bante" (China).

Sensory evaluation of the instant coffee drinks samples was performed by using a Profile Attribute Analysis (ISO 13299:2016).

Assessor’s panel include 9 trained panellists at ages ranging from 30 to 60 years old, selected according to the guidelines of the ISO (female: \( n = 7 \); male: \( n = 2 \)). All panellists were trained and exposed to several screening tests before the beginning of the sessions of sensory evaluation. Sensory attributes of the instant coffee drinks samples were selected in a preliminary session (Tabl.1). The assessors were asked to indicate and rate the intensity of their perceptions for each of sensory attributes on a 10-point intensity scale.

Hedonic ranking test was performed for evaluation of the taste preferences according to the 35 subjects’ degree of liking from 1 – the most preferred to 5 – the least preferred.

Statistics was performed using MS Excel 2019. All analyses were executed three times and data are presented as mean ± standard deviation. Through Fisher test the differences was considered statistically significant when \( P \) value is < 0.05.

### Table 1. Sensory attributes and descriptions

<table>
<thead>
<tr>
<th>Sensory attribute</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Coffee aroma</td>
<td>Aroma of the regular coffee, perceived during the degustation but through the retro nasal olfaction</td>
</tr>
<tr>
<td>Milk aroma</td>
<td>Aroma of the regular pasteurized milk, perceived during the degustation, but through the retro nasal olfaction</td>
</tr>
<tr>
<td>Off-flavours</td>
<td>Presence of undesirable flavours in coffee</td>
</tr>
<tr>
<td>Acidity</td>
<td>Perception of acidity related to citric or other fruit acids</td>
</tr>
<tr>
<td>Bitterness</td>
<td>Perception of bitter taste related to quinine or caffeine</td>
</tr>
<tr>
<td>Astringency</td>
<td>Dry and rough feeling in the mouth and contraction of the tongue tissue related to tannins</td>
</tr>
<tr>
<td>Sweetness</td>
<td>Perception of sweetness related to white sugar or browned sugar</td>
</tr>
</tbody>
</table>

3 Results and discussion

In the coffee industry, quality control of the product range is carried out mostly through sensory analysis. The control of some physicochemical parameters concerning the storage of the dehydrated mixes of instant coffee drinks (like the moisture content and pH value) is also performed. The content of total sugar and reducing substances are analysed in order to answer the high consumer demands for low-calorie and "no added sugar" drinks (Table 2).
Table 2. Physicochemical parameters of instant coffee samples

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Sample</th>
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<tbody>
<tr>
<td></td>
<td>SUS</td>
<td>STS</td>
<td>CLS</td>
</tr>
<tr>
<td>Moisture content, %</td>
<td>1.15±0.18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.34±0.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.74±0.14&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total sugar content, %</td>
<td>64.74±1.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.10±1.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62.14±1.43&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(as invert sugar)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reducing substances, %</td>
<td>13.24±1.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.3±1.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.10±1.32&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(as invert sugar)</td>
<td></td>
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<tr>
<td>pH</td>
<td>6.54±0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.49±0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.81±0.24&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

The data from table 2 shows slightly significant differences between the samples regarding the indicators of moisture and no differences in pH value. Regarding the total sugar content, sample STS has the lowest value, it has about 70% lower total sugar content than sample SUS and sample CLS. A similar trend is also observed with the content of reducing substances, sample STS has about 45% lower content of reducing substances than the samples with sucrose.

Hygroscopicity can be describe as the capacity of a dry product to react to the moisture content of the air by absorbing or releasing water vapor. Hygroscopicity is one of the main indicators of dehydrated soluble coffee drinks and can be very important for their stability and correct preservation during the storage [16]. Predominantly, the composition of the dry mixes affects the hygroscopicity of the “3 in 1” coffee drinks. On this occasion, the sorption properties of the analysed samples were monitored at a relative humidity of φ=68% at a temperature of 20±2 °C.

![Fig. 2. Sorption properties of instant coffee samples at φ=68%](image)

Figure 2 graphically displays the sorption properties of each of the “3-in-1” instant coffee samples. The sample obtained in manufacturing conditions with the participation of sugar shows the highest hygroscopicity levels. At 15 days, sample SUS has increased its initial moisture about 0.5%, while sample STS about 0.3%, sample CLS (used for the control) about 0.23% compared to the initial moisture content.

![Fig. 3. Sensory profiles of instant coffee samples](image)

![Fig. 4. Hedonic acceptability of instant coffee samples](image)

Certainly, the major flavour function of sucrose is to give a sweet taste. But it is approved that sucrose can also affect the flavour quality of foods and drinks in diverse other ways [17, 18]. Sucrose interacts with food and drinks ingredients in many different ways. Stevia can also enhance the flavor of other ingredients. Isomalt is an odorless sweetener substance and can be used without masking flavors of other products in the content, which is a limitation of some other sweeteners.

According to results obtained from sensory analysis in this study, the samples SUS and CLS (they both contains sucrose) demonstrates an enchanted coffee aroma in trained assessors’ results (Fig. 3).

Coffee sample with isomalt and stevia (STS) reveals the more intense sweetness than other two sample. The hedonic acceptability of this sample varies in the range between “preferred” and “neutral”.

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<sup>Fig.2</sup>. Sorption properties of instant coffee samples at φ=68%
<sup>Fig.3</sup>. Sensory profiles of instant coffee samples
<sup>Fig.4</sup>. Hedonic acceptability of instant coffee samples
There is no significant difference among three samples concerning the off-flavours, acidity, bitterness and astringency sensory attributes. All four was perceived in a very low levels of intensity.

The term “intensity” of the coffee refers to an overall character of the coffee drinks but mostly how rich is the aroma of the coffee in the combination of its “body” as a mouth feeling. Intensity is one of the most difficult attributes to measure in sensory evaluation of the coffees. In this study intensity of the coffee samples was evaluated as a hedonic perception.

The samples with sucrose (CLS and SUS) demonstrated the better acceptance for all sensory attribute evaluated through hedonic scale of preferences.

4 Conclusion

Performed sensory evaluation of the three instant coffee samples type “3 in 1” reveals the there is a significant difference in perception of sweetness between classic ones with sucrose and this one with isomalt and stevia. Regardless the lower level of total sugar content and reducing substances the sample with isomalt and stevia (STS) shows a higher value in sweetness sensory perception. The two samples with sucrose CLS and SUS dominate with better hedonic acceptation and enhanced coffee aroma than STS sample.

Combination of isomalt and stevia as a sweetener can be an advantage for some health benefits but it takes time to be better accepted by consumers as a sweetener in classic recipes like “3 in 1” instant coffee drinks.

References