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A three-step sensory-based approach to maximize consumer acceptability for new low-sugar licorice-chocolate-flavored milk drink

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ABSTRACT

Licorice has many functional characteristics. The present study aimed to 1) develop a new flavored dairy beverage containing licorice extract powder (LEP) and cocoa powder (CP); 2) maximize the consumer acceptability of the beverage, using a three-step sensory-based approach, and 3) verify the physicochemical and microbial stability of the beverage during refrigerated storage. In the first step, 16 formulae containing four CP:LEP ratios (0.85:0.15, 0.70:0.30, 0.55:0.45, 0.40:0.60) and four sucrose levels (2, 4, 6, 8 g 100 g^{-1}), and a control sample (chocolate milk), were evaluated by a liking test. Second, the three formulations that obtained the highest liking scores were assessed, using a preference ranking test. Third, a second liking test was performed on the significantly most preferred formulation (CP:LEP, 0.70:0.30; sucrose, 6 g 100 g^{-1}) and three of its variants. Based on the sensory results, the milk drink was optimized at 0.65:0.35 CP:LEP and 5% sugar. During 14 days at 4 °C, the optimum drink formula showed no significant changes in acidity, pH and microbial growth and a significantly higher color and sedimentation stability than the control. Consequently, licorice showed promising potential to be used in the formulation of acceptable functional milk products, such as low-sugar flavored drinks.

1. Introduction

In recent decades, consumer preferences in the field of food products and diet have altered considerably, mainly due to an increasing recognition of the impact of foods on human health (Mollet & Rowland, 2002). Besides satisfying hunger and nutrient needs and guaranteeing acceptable sensory attributes, the functionality of foods is another attractive factor influencing consumers' choice, and they usually transpire to buy health-promoting foods or drinks that deliver health benefits. The global functional foods market is expected to extend even further, as consumers are becoming more aware of diseases, such as diabetes and obesity. It is therefore anticipated that the dairy-based products, particularly beverages, will account for an important fraction of the functional foods market (Fagan, O'Donnell, Cullen, & Brennan, 2006).

Glycyrrhiza glabra, known as licorice or sweet wood, is a perennial leguminous plant and widespread in various countries, including Spain, Italy, Turkey, Iraq, Iran, Central Asia and China (Casulli & Ippolito, 1995). The licorice root extract seems to have countless applications in industry, from a low-calorie sweetener with no or small side effects, and a color and flavor enhancer/modifier, to a foaming agent in various beverages, foods and chewing gums (İbanoğlu & İbanoğlu, 2000; Karaaslan & Dalgıç, 2014). In modern medicine, licorice extracts are often incorporated as a flavoring additive, to mask the bitter taste of other drugs (Wang et al., 2013) or as a soothing remedy for diseases of the respiratory tract and peptic ulcers (Karaaslan & Dalgıç, 2014). The main active ingredient in licorice is glycyrrhizin, a triterpenoid glycoside, 30–100-fold sweeter than ordinary sugar (sucrose) (Miremadi, Ezatpanah, Larijani, Azizinezhad, & Motaghian, 2011). Its flavonoids have exceptionally potent antioxidant activity; over 100 times stronger than that of vitamin E (Morsi, El-Magoli, Saleh, El-Hadidy, & Barakat, 2008). However, its use in foods has been limited to some extent, due to its potential cause of development of pseudoaldosteronism, which may lead to hypertension. Notwithstanding, licorice and its derivatives are confirmed to be Generally Recognized as Safe (GRAS) for use in foods by the United States Food and Drug Administration and many other countries worldwide (Isbrucker & Burdock, 2006). The findings of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) on available data proposes that an intake of 100 mg glycyrrhizic acid per day is unlikely to cause any harmful effect in the health of the majority of adults (WHO., 2006). In studies on the application of licorice in food formulae, Zhang, Feng, Wu, and Jiling (2005) reported characteristics of a novel functional beverage based on licorice and apple juice. Also,

Abbreviations: CP, cocoa powder; LCMD, licorice-chocolate-flavored milk drink; LEP, licorice extract powder

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Jiang, Zhang, True, Zhou, and Xiong (2013) investigated the efficacy of licorice extract to decrease lipid oxidation and preserve the sensory attributes of ground pork during refrigerated and frozen storage.

The consumption of various flavored milk drinks is common among all age groups in many countries, with chocolate-flavored milk considered the most popular (Yanes, Durán, & Costell, 2002). Thus, it was decided to select chocolate-flavored milk as a base beverage to be supplemented with licorice extract powder (LEP). Although Iran has always been a major producer and exporter of licorice extract products, there are no licorice-based foods in its market. Therefore, investigating the characteristics of this new functional beverage is interesting and worthwhile. The first objective of the present research was to develop an optimum formula for a milk-based, low-sugar beverage supplemented with LEP. This new formula containing licorice and chocolate is referred to as a licorice-chocolate-flavored milk drink (LCMD) in the remainder of this document. The second aim was to maximize the consumer acceptability of the new drink by a three-step sensory-based approach. It was expected not only to accomplish consumer acceptance regarding sensory attributes but also to maintain physicochemical and microbial stabilities during refrigerated storage. Therefore, the third aim of this study was to verify the stability of the new drink over storage at 4 ± 1 °C.

2. Materials and methods

2.1. Chemicals and ingredients

LEP was provided by Shiraz Rishmak Plant (Barakat Co., Tehran, Iran). Commercial milk (fat, 1.5 g 100 g^{-1}) was purchased from a local dairy company (Pegah Fars Dairy Co., Shiraz, Iran). Plate count agar (PCA) and yeast-extract glucose chloramphenicol agar (YGC) were from Merck (Germany), and phenolphthalein and sodium hydroxide (NaOH) were from Sigma Chemical Co. (USA). The remaining ingredients were cocoa powder (CP) (Bensdorp, Netherlands), kappa-carrageenan (Behin Azma Co., Iran) and sugar (local market).

2.2. LCMD

There are no published data on the formulation, physicochemical and sensory characteristics of a milk-based beverage containing licorice extract. The drink in this study was formulated based on a commercial chocolate milk drink formulation produced by Ramak Dairy Company (Shiraz, Iran). Its ingredients, apart from milk, are 1 g 100 g^{-1} CP, 8 g 100 g^{-1} sugar and a maximum 0.3 g 100 g^{-1} stabilizer. Therefore, an initial study was required, to select the appropriate ingredients (types and amounts) and to optimize these ingredients. The first group of drinks was formulated using 0.1–1.0 g 100 g^{-1} LEP. Subsequently, considering the acceptable daily intake for glycyrrhizin (100 mg day^{-1}) (WHO., 2006) and based on the sensory results, 16 formulae containing four CP:LEP ratios (0.85:0.15, 0.70:030, 0.55:0.45 and 0.40:0.60), four sucrose levels (2, 4, 6 and 8 g 100 g^{-1}), skim milk powder (2 g 100 g^{-1}) and stabilizer, were prepared (Table 1). It is notable that the sum of cocoa and LEP was equivalent to the 1 g 100 g^{-1} CP used in the commercial drink. Kappa-carrageenan is the most widely used hydrocolloid in chocolate milk, due to the interactions of carrageenan molecules with the casein micelles and the resultant stability afforded to chocolate milk beverage systems (Langendorff et al., 2000). A number was assigned to each sample (1–16) and the control (17 samples in total). Each formula was batch-pasteurized at 85 ± 2 °C for 5 min (Iserliyska, Chinnan, & Resurreccion, 2012). The samples were hot-filled in plastic containers, hermetically sealed and stored at 4 ± 1 °C for 14 days (Fromm & Boor, 2004).

Table 1
Formulation of the 17 samples of licorice-chocolate-flavored milk drink.[a]

Sample	CP:LEP (total equivalent 1 g 100 g^{-1} CP)	Sugar (g 100 g^{-1})
Control	1:0	8
1	0.85:0.15	8
2	0.70:030	8
3	0.55:0.45	8
4	0.40:0.60	8
5	0.85:0.15	6
6	0.70:0.30	6
7	0.55:0.45	6
8	0.40:0.60	6
9	0.85:0.15	4
10	0.70:0.30	4
11	0.55:0.45	4
12	0.40:0.60	4
13	0.85:0.15	2
14	0.70:0.30	2
15	0.55:0.45	2
16	0.40:0.60	2

[a] All samples contain 0.03 g 100 g^{-1} kappa carrageenan and 2 g 100 g^{-1} skim milk powder.

2.3. Sensory analysis

2.3.1. Subjects

The beverages were sensorially evaluated by a panel of 20 subjects (8 males, 12 females; aged 17–30 years; mean age, 23 years) who declared to consume milk and flavored milk drinks daily. Participants had received an invitation to participate in the study and volunteered based on their interest and availability. Written informed consent was obtained from each subject after the experiment was described to them. Participants declared to have no allergies or intolerances to licorice, sucrose, milk and pectin. All tests were conducted in individual booths, and social interaction was not permitted. Each subject participated in a three-step sensory evaluation.

2.3.2. Step 1 - liking test 1

The initial large number of samples (17, Table 1), together with an intense sweetness and after-taste, which is usually associated with the presence of LEP in the formula (Hartung, 1979; Hough, Parker, & Vlitos, 1979) made a one-session sensory analysis in the present study almost impossible. Thus, a complete block design (Meilgaard, Civille, & Carr, 2015) was applied. The tests were conducted in three sessions on three consecutive days. Subjects evaluated six, six, and five samples in the first, second and third session, respectively. In each session, the experimenter verbally introduced the consumers to the data collection procedure. The samples (30 mL) were served in blind conditions, in a transparent plastic cup (100 mL) hermetically sealed with a plastic lid and coded with a random three-digit number. Samples were served in a completely randomized and balanced order among the subjects, following a complete block design, and evaluated at 15 ± 1 °C. Subjects were instructed to observe, smell and taste the samples and to rate their liking for color/appearance, taste/flavor, texture/mouthfeel and overall acceptability on a five-point hedonic scale, ranging from “dislike extremely” (1) to ”like extremely” (5) (Peryam & Pilgrim, 1957). Participants rinsed their mouth with still water for 3 min before beginning the test and between samples. Consumers took 35–40 min to complete their evaluation in each session.

2.3.3. Step 2 - preference ranking test

Results of the liking test were used for selecting the samples to be further analyzed. The three formulations that obtained the highest liking scores were evaluated by a preference ranking test. The test was performed in a session during the fourth day of data collection. The sample presentation and assessment procedure were the same as those adopted for the liking test. Subjects were required to rank the samples