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Obtaining a Functional Product from Soy Milk Fortified with Blackcurrant Extract

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Abstract: Food is an important factor in maintaining well-being, which is why people should pay special attention to the food they eat. Cardiovascular and metabolic diseases are increasingly widespread among the population, being accentuated by the active lifestyle, lack of sleep, physical activity or unhealthy diet. This work highlights the bioactive role of black currants and the benefits they bring to health, as well as obtaining a bioactive product that has as raw materials in its composition: soy milk and currants. Starting from Hippocrates' motto, ”Let food become your medicine”, I believe that functional products have an essential role in maintaining health. The main purpose of the work is to identify the properties of red and black currant fruits, in different forms of presentation, in order to be used as a fortifying element in a soy-based food product, which stands out through the physico-chemical, organoleptic and microbiological properties provided of quality standards.

Keywords: bioactive, currant, functional, health, soy milk

Introduction

1.1 The beneficial effects of soy milk/soy products on the human body

Soy has been cultivated since ancient times, the first mentions of it appeared in Chinese literature. It derives from the wild species *G. Ussuriensis*, as Morse stated in 1950. Due to its benefits and multiple uses in human nutrition, it was considered one of the five holy plants of Chinese civilization (Giosan, 1986).

Due to the high content of proteins, essential amino acids and the high content of fiber, iron and vitamins (Montgomery, 2003), soy can be used as a basic raw material to obtain various food products. It contains all the essential amino acids (Henkel, 2000). Rezi and Muresanu (2013), highlighted the main characteristics that soybeans must present in order to be used in the food industry: high protein content, light color and low content of allergens.

The chemical composition of soybeans, the organoleptic properties, as well as the benefits brought to health make it remarkable for its use as a main ingredient in obtaining functional products.

”The term functional food refers to a modified food that claims to improve health or well-being by providing benefits beyond those of the traditional nutrients it contains” (Abdel-Salam, 2010).

Soy proteins are responsible for lowering blood pressure, and isoflavones play an important role in the prevention of blood clots (Asif and Acharya, 2013).

The low content of saturated fats and cholesterol is associated with the reduction of heart diseases and diabetes, having an alkalizing action on the blood (Ezekiel and Fapohunda, 2012).

Members of the European Food and Drug Association say that diets that include 25-50 grams of soy protein per day can help lower LDL cholesterol levels. During menopause, soy phytoestrogens ensure the balance of estrogen levels in the body, which is why soy must be included in the woman's diet.

Soy is considered a miracle plant, due to its high protein content 40% high quality protein, compared to wheat (12%), corn (10%), rice (7%), isoflavones giving it protective properties against different types of cancer: breast, prostate, colon and lungs (Ambannavar et al., 2017).

The incidence of prostate cancer among Asians, known for their high consumption of soy, is due to a phytoestrogen contained in soy, genistein (Dalu et al., 1998).

After several clinical trials, it was concluded that the introduction of soybeans into the diet, 25 grams of soy protein, can reduce plasma levels of low-density lipoproteins (LDL). FAO, mentioned in 1999, the fact that a diet based on low consumption of saturated fats and the consumption of 25 grams of soy products, can reduce the occurrence of cardiovascular diseases (Balk et al., 2005).

Soy milk is the most consumed soy-based product, because it replaces cow's milk, being highly appreciated by vegetarians, people

with lactose intolerance or milk protein allergy (Reilly et al., 2006). It does not contain cholesterol, it is rich in protein and iron, and compared to cow's, it is lower in sodium and fat. Regarding the calcium content, it is much lower than cow's milk, which is why soy milk is often fortified with calcium (Birgersson et al., 2009).

Most of the articles on soy and soy milk have focused on the technological process to obtain them as functional products, recently increasing interest in such products; Soy milk is often fortified with vitamins, minerals and calcium (Berk, 1992).

Soy is used in food due to its health benefits and affordable price. The disadvantage of its use is the presence of anti-nutritional factors, which limit its consumption (trypsin inhibitors, lecithin, phytic acids and indigestible oligosaccharides). Following the application of heat treatment, an improvement in protein digestibility was demonstrated, and some compounds such as phytic acid, which interacts with calcium, are not sufficiently reduced (Jiang et al., 2013).

Even if it contains important amounts of bioactive compounds, such as phenolic compounds, isoflavones, phytoestrogens, the presence of anti-nutritional factors in soy: trypsin inhibitors, lecithins, phytic acids and indigestible oligosaccharides have reduced its consumption and led to the finding of methods for theirs elimination (Onuorah et al., 2007).

1.2 The beneficial effects of currants on the human body

Based on the data presented in the specialized literature, I believe that the blackcurrant fruit can be considered an important source of bioactive compounds, with a prophylactic and curative role. Of the 150 species, the most important are Ribes nigrum (Figure 1.a) and Ribes rubrum (Figure 1.b), the main producers in Europe (Russian Federation, Poland, Ukraine, Netherlands, France) (Zdunić et al., 2016).

Currant fruits are a good source of mineral and natural antioxidant substances (Borges et al., 2010; Lugasi et al., 2011; Wojdyło et al., 2013; Nour et al., 2014; Cosmulescu et al., 2005). These are notable for their high ascorbic acid content, which varies in fruit 44–218 mg/100 g (Walker et al., 2006), 50–350 mg/100 g (Badejo et al., 2008; Osokina et al., 2021), according to other data — 100–200 mg/100 g (Brennan et al., 2008), 100–300 mg/100,

depending on the genotype and only then on the weather conditions during the crop formation (Osokina et al., 2020).

Due to the increased bioavailability of vitamin C, it is one of the most important antioxidant components in blackcurrant fruits (Levine et al., 1996). The potassium content is twice that of bananas, vitamin C is four times that of bananas and twice as many anthocyanins compared to blueberries (Harrison and Smith, 2016).

Flavonoids, phenolic compounds, terpenoids, are responsible for the antimicrobial and antioxidant activity, having an important role on health (Yang et al., 2016).

Cosmulescu Sina et al., 2015, highlighted the antioxidant properties of black and red currants, making a comparison regarding the mineral content of seven varieties of currants grown in Romania. The order of nutrients, depending on their content/100 g of fruit, was: K > Ca > Mg > Fe > Al > Na > Mn > B > Cu, obtaining the following values for different mineral substances: the average content of potassium (249.69 mg/100 g for black currants and 197.32 mg/100 g for red currants), the average calcium content in black currants is 36.14 mg/100 g and 25.76 mg/100 g in red currants, Magnesium content (13 mg/100 g for red currants and 24 mg/100 g for black currants).

Iron content 1.09 mg/100 g - 3.29 mg/100 g. Aluminum, sodium, manganese, boron and copper were found in smaller amounts, less than 1 mg/100 g. Aluminum content varied between 2.61 and 0.42 mg/100 g, manganese between 0.49 and 0.18 mg/100 g, boron between 0.43 and 0.13 mg/100 g and copper between 0, 17 and 0.09 mg/100 g. (Cosmulescu et al., 2015).

The significant amounts of anthocyanins, from black currants, have beneficial effects in reducing inflammation, fighting oxidative stress, as well as anticancer properties, there are studies that highlight the positive effects of currants in fighting cancer (Cooke et al., 2005; Wang and Stoner, 2008; Bishayee et al., 2010).

The main bioactive compounds from blackcurrant and the health benefits, including: reduction of oxidative stress, anti-inflammatory, hypocholesterolemic, phytoestrogenic effect, are presented in table 1. (Cortez et al., 2019).

Figure 1.a – Black currant (*Ribes nigrum*); Figure 1.b – Red currant (*Ribes rubrum*)
Source: https://ro.wikipedia.org/wiki/Coac%C4%83z_negru/ https://www.warentuin.nl/fruitplant-ribus-rubrum-fruitboom-oosterik-home

Table 1
Examples of health benefits and associated compounds found in blackcurrant products

Blackcurrant product used	Compounds	Beneficial properties for health	References
Whole grains and juice	Cyanidin 3-glucoside, cyanidin 3-rutinoside, delphinidin 3-glucoside, delphinidin 3-rutinoside and ascorbic acid	Antioxidant (reducing oxidative stress by eliminating free radicals) Anti-inflammatory (in vitro) Hypocholesterolemic (mice and rats) Increased cellular uptake of LDL, decreased postprandial blood glucose phytoestrogens (in vitro), improves glucose tolerance (mice and rats and humans) Increases Fat Oxidation (Humans)	Bender et al. (2017), Braakhuis et al. (2014), and Lyall et al. (2009) Benn et al. (2014), Lyall et al. (2009) and Shaw et al. (2017) Cook et al. (2017a) Nanashima et al. (2018) Cook et al. (2017b) Woznicki et al. (2017)

		Collagen biosynthesis and production of peptide hormones.	Cortez et al. (2019)
Seed	Acid gamma linoleic	Antioxidant Potential attenuation of inflammatory responses	Nour et al.2013 Cortez et al. (2019)

(Source: Cortez et al., 2019).

1.3 Obtaining and characterization of currant extracts

Black currants can be used in different forms: fresh, frozen, in the form of dry extracts, oils, juices, syrups, as additional elements in gastronomy. Dried fruits are appreciated due to the large amounts of anthocyanins, being used in pharmaceutical products or as a dye in various preparations (Mattila et al., 2016).

The owners and the chemical composition of currants recommend them for use in functional products (Ersoy et al., 2018).

Gudkovskii et al. (2020), checked the storage method and duration of blackcurrant fruits, reaching the following conclusions: in the controlled atmosphere, the fruits can be stored at a temperature from 0 to 1°C for 45 days, the storage time in the normal atmosphere being 5-7 days. The following were followed: the losses due to gray mold, the sensory and physico-chemical properties (Gudkovskii et al., 2020).

The blackcurrant is cultivated especially in Europe, using both the berries to obtain jams, jellies, nectars and juices, or flavoring various dishes, as well as the buds or leaves (Orav et al., 2002).

The main product obtained by processing black or red currants is represented by currant juice. Over time, the advantages produced by the enzymatic treatment have been highlighted, the most common being the following: the increase in juice production by 91%, the decrease in the viscosity of the juice or the increase in the concentration of phenols (Bender et al., 2017; Laaksonen et al., 2014; Cortez and Gonzalez de Mejia, 2019). The increased viscosity negatively influences the pressing stage, which is why it requires the use of enzymatic treatments in the technological flow of obtaining juices (Bender et al., 2017; Cortez and Gonzalez de Mejia, 2019).

1.4 Obtaining soy milk. General

The soy sauce can be obtained from two basic raw materials: soy and water, and can be fortified with calcium, vitamins or different flavors, which contribute to the taste improvement.

Soy milk contains cholesterol, is rich in protein and iron, and compared to cow's milk, it is lower in sodium and fat. Regarding the calcium content, it is much lower than cow's milk, which is why soy milk is often fortified with calcium (Birgersson et al., 2009). Even if it contains important amounts of bioactive compounds, such as phenolic compounds, isoflavones, phytoestrogens, the presence of anti-nutritional factors in soy: trypsin inhibitors, lecithins, phytic acids and indigestible oligosaccharides have reduced its consumption and led to the finding of methods for theirs elimination (Onuorah et al., 2007).

In order to obtain functional soy milk, different bioactive compounds are added that have positive effects on health and prevent the occurrence of certain diseases (Onuorah et al., 2007). Soy milk is often fortified with vitamins, minerals and calcium (Berk, 1992).

Obtaining soy milk in the traditional system brings a series of disadvantages. These are especially related to the specific unpleasant taste resulting from the oxidation of soybean oil with the formation of ketones and aldehydes, especially hexanes and heptanes. Different methods have been found to be able to fix these defects (De, 1971).

The specific aroma of beans, from soy milk, could be mitigated by adding flavors (Syamsuri and Lestari, 2021).

The thermal treatment applied to soybeans has the ability to significantly reduce the activity of the trypsin inhibitor, Yuan et al. (2008), mentioned a reduction of it from 29.6 mg/g of lyophilized soy milk powder to 14.7, but it can negatively influence the amount of essential amino acids, by destroying them (Ma et al., 1996).

Improving the organoleptic properties of soy milk, by reducing anti-nutritive factors, has been shown to be possible by applying the germination of soybeans, a process that leads to: increasing the content of vitamins (for example, vitamin C and riboflavin), improving the digestibility of proteins, hydrolysis gas-causing oligosaccharides, reducing the level of trypsin inhibitors, lectin, phytic acid and lipoxygenase activity, which give the unwanted

bean flavor and increasing the content of phenolic compounds glycosines and isoflavones (Jiang et al., 2013).

1.5 Obtaining soy milk. Technology

After the qualitative and quantitative reception of the soybeans, it is processed first (cleaned, cut and pressed). Next, a heat treatment is applied, which has the role of inactivating the enzyme responsible for their digestibility.

A stage of coarse grinding of the beans follows, followed by their finishing, resulting in a warm white suspension with tiny insoluble soy particles. These particles are separated from the soy milk suspension using a centrifuge (Made How, 2007).

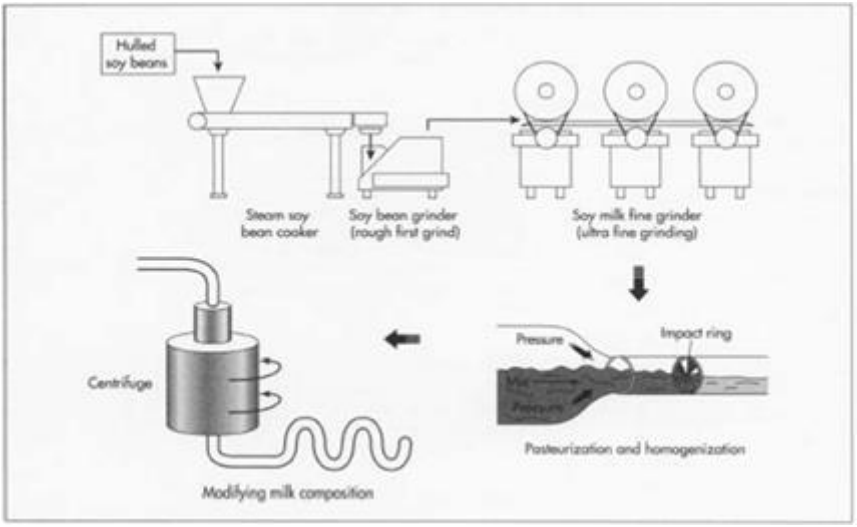

Figure 2. Soy milk production technology
Source: http://www.madehow.com/Volume-5/Soy-Milk.html

The main operations of the general technological flow of obtaining soy milk in the industrial system are: washing and peeling, soaking beans, rinsing, grinding beans, rinsing, centrifugation, pasteurization and homogenization. (Figure 2) (Made How, 2007).

The technological scheme for obtaining soy milk in an industrial system is the following (Figure 3).

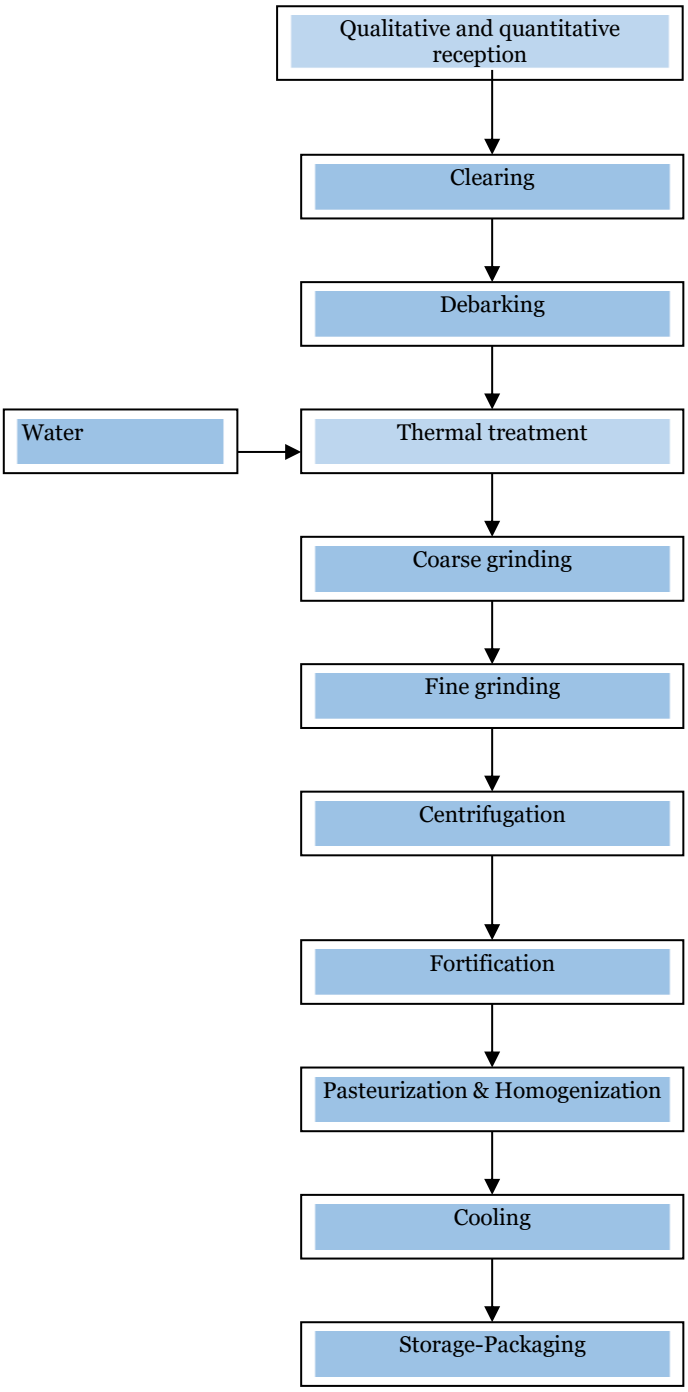

Figure 3. The technological scheme for obtaining soy milk in an industrial system

Conclusions

The information presented represents the preliminary study in order to evaluate the possibility of making a functional product from soy milk fortified with currant extract, which will be analyzed from an organoleptic, physico-chemical and microbiological point of view.

Considering the many benefits it has, soybeans are often used in human nutrition, representing an important source of nutrients.

Soy milk is an appreciated drink, due to its nutritional value, similar to cow's milk, it does not contain cholesterol, rich in proteins, iron and bioactive compounds (isoflavones, phytoestrogens, phenolic compounds).

To improve its properties, it can be fortified with currant extracts, following the protective effect of the bioactive compounds present in them.

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