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Review

Improving functionality of chocolate: A review on probiotic, prebiotic, and/or synbiotic characteristics

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ABSTRACT

Background: Chocolate is consumed by people of all ages in all segments of society throughout the world. The popularity of this food is mainly associated with its potential to arouse sensory pleasure and positive emotions. Increasing awareness of the link between healthy eating and well-being is reflected in the current views of the general consumers. Consumers perceive functional foods as a member of the specific food category to which they belong. Also, in developed economies, a key trend at the moment is confectionery products that deliver functional benefits for health and well-being, such as functional chocolate.

Scope and approach: In this review, studies related with production of prebiotic, probiotic and synbiotic chocolates as a functional food were investigated and positive and negative aspects of these functional products when compared with standard one were stated, which could shape the following related studies in food area and the production of prebiotic, probiotic and synbiotic chocolates in the food industry.

Key findings and conclusions: When the studies related with this topic were investigated it could be concluded that the studies associated with chocolate which could play a role in transportation of probiotics and prebiotics might be supported by studies in which bioavailability and bioaccessibility characteristics of them *in vivo* and *in vitro* media will be determined. Moreover, in order to improve bioavailability and bioaccessibility properties product quality optimization studies might be required in the future.

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1. Introduction

Chocolate is, in essence, composed of cocoa mass and sugar suspended in a cocoa butter matrix (Andarea-Nightingale, Lee, & Engeseth, 2009). Primary chocolate categories are known as dark, milk and white that differs in content of cocoa solid, milk fat and cocoa butter in the formulation. Chocolates are semisolid suspensions of fine solid particles of sugar and cocoa (and milk, depending on type); making about 70% in total, in a continuous fat phase (Afaokwa, 2010). Chocolate is consumed all over the world, in all segments of society and by people of all ages. The popularity of this food appears to mainly associate with its potential to arouse

sensory pleasure and positive emotions (El-Kalyoubi, Khallaf, Abdelrashid, & Mostafa, 2011).

Increasing awareness of the link between diet and health is reflected in the current views of the consumers all over the world (Harwood, 2013). The rise in cardiovascular disease and obesity and in other diet-related illnesses has led to consumers taking a greater interest in the ingredients of food products and valuing those with functional foods. Consumers prefer to consume functional foods as a member of the specific food category to which they belong (Ares, Besio, Gimenez, & Deliza, 2010). The preference for healthier and convenience products has led to a growing demand for functional and ready-to-eat foods that present a suitable sensory acceptance (De Morais, Lima, De Morais, & Blini, 2015).

Motivation elements of consumers in preference of foods have changed especially in the last 20 years. Healthfulness is the main driver of food purchasing behind taste and price and the presence of added beneficial components and fortification have at least

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positive impact on purchasing decisions (Harwood, 2013). Moreover, consumers prefer natural and organic foods or additives, which also be taken into consideration during production. The preference in consumer behavior and choice has directed scientific researches as well as industrial product development activities.

Food companies are constantly searching for ways to innovate and develop novel or improved products to stay competitive (De Pelsmaeker, Gellynck, Delbaere, Declerq, & Dewettinck, 2015). Functional foods have gained prominence in the market, with a large number of products being developed (Morato et al., 2015) and confectionery industry, especially cocoa and chocolate industries are undergoing dynamic changes in recent years, influenced by increased demands for healthy (Belscak-Cvitanovic et al., 2015) or functional chocolates.

Foods with wide acceptance and consumption have been enriched with ingredients that potentially improve the consumers' health. For instance, reducing the fat content in the diet decrease the energy intake and therefore, contribute to the prevention of obesity. There is an opportunity using indulgent foods, such as chocolate to achieve this aim (Rezende, Benassi, Vissotto, Augusto, & Grossman, 2015). Those expectations and inconsistencies warrant the high interest of continuing researches on this area (Fernandez-Murga, Tarin, Garcia-Perez, & Cano, 2011). In developed economies, a key trend at the moment is confectionery products that deliver functional benefits for health and well being, such as sugarless sweets and functional chocolate (Belscak-Cvitanovic et al., 2012).

Within the last several years functional chocolate has gained popularity in America. 35% of Americans have favoured the consumption of chocolate that strengthens the immune system (Saka, 2011). Also, they are longing for chocolate that helps them relax (41%) and 38% for “feel good” (38%) (Callebaut, 2008). Meeting these expectations of consumers could be provided by reducing concentration of functional properties. An increasing number of studies in recent years point towards this trend.

It is required to describe the specific functional term for chocolate and confectionery products. Functional confectionery has been defined as ‘a confectionery item that has undergone the addition, removal or replacement of standard confectionery ingredients with an ingredient that fulfills a specific physiological function or offers a potential health benefit’ by Pickford and Jardine (2000). An European Union directive simplified previous legislation opening up new possibilities for chocolate makes to try new ingredients, which can be used to create new products beneficial to consumers and industry (Bolenz, Amtsberg, & Schape, 2006). This regulation led up the production or improvement of chocolate with functional properties, which can be labeled as a standard chocolate. It also mentions that the new freedom chocolate producers have regarding the ingredients of their chocolate, which opens up interesting possibilities for reducing percentages of expensive cocoa and milk ingredients. Soluble and insoluble fibers, prebiotics, vitamins and minerals, herbal extracts and other phytochemicals are the main ingredients, which are used as substitutes or enrichment agents.

Consumers' sensory and hedonic perceptions could be greatly influenced by the messages highlighted on the front of the packaging, particularly nutrition and health claims for reduced-calorie or functional foods (Miraballes, Fiszman, Gambero, & Varela, 2014). Chocolate lovers want functional chocolate that offers clinically proven physical or emotional health benefits (Callebaut, 2008). However, consumers' attitudes towards functional foods do not depend only on their perceived healthiness, but also on the sensory quality, price and convenience, as any conventional product (Ares et al., 2010). Also, the bioactive compound added to the functional food matrix must maintain its original chemical

structure and consequent functionality during the entire shelf-life period (Botelho et al., 2014).

In this review, chocolate-based products, agreed with functional food concept, development studies were investigated. For this purpose, considering the classification of general functional food, the effects of process parameters on bioactive substances and product development studies on the main quality characteristics of chocolate, which could provide important information to the industry and literature could be researched.

2. Chocolate and health

Prominent substances are known as cacao based phenolic compounds, minerals, sugar, and proteins and carbohydrates found in the powdered milk when considering beneficial effects of conventional chocolate on health. However, it is difficult to market chocolate for health benefits since many of the original healthy components inherent in cocoa are lost during processing. The flavanol contents in cocoa products and chocolate vary greatly depending on the bean variety and origin, agricultural and processing practices. In part, the variability of flavanol contents in cocoa and chocolate may be responsible for the mixed outcomes presently observed in research on the effects of cocoa flavanols on neurocognitive and affective functions, executive control, and behavior (Sokolov, Pavlova, Klosterhalfen, & Enck, 2013). Also the sugar added in large amounts to chocolate is harmful for people consuming chocolate. Moreover, consumers' anxiety and perception in calorie reduction, dental health and obesity transforms advantageous of sugar to disadvantages.

Interest on chocolate health advantages is short since its association with protective mechanisms only has initiated in the nineties. Despite so, these less than two decades have witnessed the materialization of a huge amount of literature detailing the flavanols content of chocolate as well as an array of evidences linking them with different protective pathways (Fernandez-Murga et al., 2011).

Most studies so far have been conducted on the effects of chocolate intake on the cardiovascular system (Hooper et al., 2012; Kay, Kris-Etherton, & West, 2006), reducing urinary excretion of the stress hormone cortisol and catecholamines (Martin et al., 2010), skin, cholesterol concentrations, and the release of neurotransmitters anandamide and serotonin, and on the health-related properties of high-quality dark chocolate, containing the stimulants theobromine and caffeine (Katz, Doughty, & Ali, 2011; Lamuela-Raventos, Romero-Perez, Andres-Lacueva, & Tornero, 2005; Sokolov et al., 2013).

However, the case of chocolate is particularly unsettling, given the modifications in composition imposed by processing and the proper lack of evidence that the benefits are, or are not, due to flavanols (Fernandez-Murga et al., 2011). Potential effectiveness of these ingredients depends on bioavailability characteristics, which could be especially influenced by food matrix (Smith, 2011). The final concentration of flavanols depends on the processing treatment applied to reduce their characteristic bitterness and to gain consistency.

As a conclusion, one of the most prominent compounds added to improve functional properties are cacao based phenolic substances for chocolates produced according to conventional methods. However, increasing level of these functional compounds has risk considering sensory properties of chocolate. Astringency resulted from the addition of these compounds could negatively affect the acceptability of the products based on especially age groups, therefore, masking of these negative effects is necessary in the industry. In addition, degradation of those bioactive compounds throughout cacao based raw material production could be

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