Potential Benefits of Chocolate with Berries as a Functional Food: A Review

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ABSTRACT:*Chocolate is a good source of vitamins, minerals, and antioxidants. Adding berries to chocolate can produce helpful and healthier chocolate products with a higher nutritional value. Whether dried, powdered, or extracted, berries can be combined with chocolate to create functional and healthful chocolate products. The sensory properties of berry-infused chocolate, such as the addition of goji berries, have been investigated to determine consumer acceptability to produce an acceptable product, and bioactive chemicals found in blueberries, such as phenolics, have potential as a functional food with a positive impact on health.*

KEYWORDS: *Berries, Chocolate, Functional Food, Health, Potential*

I. Introduction

Functional foods provide health benefits in addition to essential nutrition; they contain biologically active substances in certain proportions (Martirosyan, von Brugger, and Bialow, 2021). Chocolate is increasingly recognized as a functional food due to its bioactive components, which can promote health (Samanta *et al.*, 2022).

Chocolate is a sweet food that has long been considered unhealthy due to its high fat and sugar content (Komes *et al.*, 2013). The discovery of polyphenolic antioxidants in cocoa and chocolate has challenged long-held beliefs about the negative consequences of chocolate (Zafra-Stone *et al.*, 2007; Komes *et al.*, 2013), but some studies suggest

chocolate is considered a functional food because it contains active chemicals that provide health benefits in addition to essential nutrients (Rogovska and Čukanová, 2015).

Chocolate comprises several ingredients, including cocoa solids, milk, and various additives

(Belščak-Cvitanović *et al.*, 2012). Cocoa and cocoa products are currently in high demand due to their heart health benefits. Most of these effects are due to the polyphenolic components in cocoa, especially flavonoids (Belščak *et al.*, 2009). However, not all chocolate contains the same flavonoids. Dark chocolate contains more flavonoids than milk chocolate due to its higher cocoa content. Also, since white chocolate does not include dark cocoa particles, it lacks cocoa polyphenols (Rimbach, Egert, and De Pascual-Teresa, 2011).

Numerous studies have shown that adding berries to chocolate can increase its functional value due to their polyphenol and antioxidant content (Lončarević et al., 2018). Studies have also shown that goji berries (Morais Ferreira et al., 2016), blackberries (Lončarević et al., 2018), and other berries can provide health benefits (Şat, Takım and Binici, 2024)Moreover, adding fruit to chocolate formulations has been associated with chemical and sensory enhancements and human health benefits (Żyżelewicz *et al.*, 2021).

Some studies recommend drying berries because they have a high water content (Şat, Takım and Binici, 2024), which will change the overall quality of the chocolate (Nafingah *et al.*, 2019). (Lončarević *et al.*, 2018), blackberries are encapsulated before drying by spray drying. (Żyżelewicz *et al.*, 2021)Studies showed that blueberries, raspberries, and blackberries were freeze-dried, and (Morais Ferreira *et al.*, 2016) showed that goji berries should be dried before

being added to white chocolate. The drying procedure offers the advantage of removing moisture from the chocolate, which affects its texture (Ward and Matejtschuk, 2021).

II. Literature Review

2.1 Chemical Properties

Chocolate's chemical properties are numerous, adding to its distinct qualities. Various chemicals contribute to its flavor, texture, and nutritional value. Chocolate's primary chemical components include antioxidants (flavonoids), cocoa butter, caffeine, phenylethylamine, theobromine, and other psychotropic chemicals (Munjal *et al.*, 2019).

This study showed that adding goji berries (GB) significantly increased prebiotic white chocolate's total phenolic content (TPC) and antioxidant activity. Dried goji berry samples had the highest phenolic content and antioxidant activity (Zhang *et al.*, 2016), as determined by the Ferric Reducing Antioxidant Power (FRAP) and Oxygen Radical Absorbance Capacity (ORAC) assays. In contrast, white chocolate samples without goji berries had the lowest TPC, FRAP, and ORAC values (Ferreira, 2016), indicating that the presence of goji berries, which are high in polyphenols and carotenoids, significantly adds to the antioxidant characteristics of chocolate (Belščak-Cvitanović *et al.*, 2012), in addition, this study found that the low antioxidant value of chocolate without goji berries could be due to the presence of milk proteins, which contribute little to antioxidant activity.

The study (Şat, Takım and Binici, 2024) found that adding wolfberry or goji berry to dark chocolate, which has the highest bioactive content (Samanta *et al.*, 2022), resulted in higher total polyphenol and antioxidant levels compared to chocolate without wolfberry. Aside from wolfberry and goji berries, other berries, such as blackberry, can significantly improve the functional value of chocolate.

The addition of blackberry fruit increases the total polyphenols produced. White chocolate without blackberry encapsulation contains 40.75 ± 0.96 mg GAE/100 g, while adding 100 g kg^{-1} encapsulation (WE10) increases the polyphenol content to 153.95 ± 4.10 mg GAE/100. Blackberry encapsulation alone contains 2628.96 mg GAE/100. Research (Żyżelewicz *et al.*, 2021) states the addition of the type of berry that gives significant results.

In a study by (Żyżelewicz *et al.*, 2021), blueberries, raspberries, and blackberries were used. Each sample had different total polyphenol results. However, chocolate enriched with dried phenolic-rich blueberry powder resulted in the highest percentage increase (about 80%) in total polyphenol content in milk chocolate compared to the control. The blueberry powder added approximately 32.8 mg/100 g DM of anthocyanins to the milk chocolate, which was absent from the control chocolate. Furthermore, blueberry powder contained the highest concentration of flavan-3-ols and phenolic acids.

The study (Żyżelewicz *et al.*, 2021) evaluated the antioxidant activity of chocolate by measuring its radical scavenging activity (DPPH) and iron reduction ability (FRAP). The results showed chocolate enriched with blueberry powder had higher antioxidant capabilities than chocolate without phenolic-rich plant powder. Overall, adding these phenolic-rich powders boosted both the overall polyphenol content and the antioxidant capacity of the chocolate. The study analyzed chocolate's antioxidant activity by measuring its radical scavenging activity (DPPH) and ferric-reducing ability (FRAP). The results showed chocolate enriched with blueberry powder had higher antioxidant capabilities than chocolate without phenolic-rich plant powder. Overall, adding these phenolic-rich powders boosted both the overall polyphenol content and the antioxidant capacity of the chocolate.

Fruit-enhanced chocolate can also boost the total polyphenol, flavonoid, and antioxidant content. Research indicates that natural fruit-derived compounds are increasingly used as antioxidants (Xin, 2017). This presents an opportunity to boost polyphenol and antioxidant content in chocolate formulations with berries (Żyżelewicz *et al.*, 2021). Whether through dried fruit, fruit powders, or fruit extracts, mixing fruit with chocolate can result in functional and healthier chocolate products with a higher nutritional profile.

2.2 Sensory Properties

Sensory is a scientific discipline that analyses and interprets responses to the qualities of food items as perceived by the senses of sight, smell, and taste. Sensory characteristics of food quality

are measured to identify consumer acceptance/preferences to generate acceptable and effective products while maximizing production economics. Sensory characteristics include appearance (color, size, form, and consistency of liquid and semisolid items), texture, consistency, viscosity, and taste (flavor and odor) (Jain and Gupta, 2005).

The sensory qualities of goji berry-infused chocolate have been studied. The study (Morais Ferreira *et al.*, 2016) included three treatments:

1. The addition of sucrose and goji berries
2. The addition of sucralose and goji berries
3. The addition of rebaudioside A and goji berries

Sensory analysis was used to evaluate the chocolate across several factors. The panelists were untrained (120 persons), and the samples were determined using an acceptability test with a just-about-right (JAR) scale ranging from significantly less sweet than ideal' to very more sweet than perfect,' with the midpoint of the scale corresponding to 'ideal.' Overall, panelists rated the sensory outcomes, demonstrating that combining goji berries and the high-intensity sweetener sucralose can produce a product that matches consumer preferences while increasing the nutritional profile of white chocolate. According to (Morais Ferreira *et al.*, 2016), replacing sucrose sweetener with sucralose seeks to lower sugar content for health-conscious consumers (Yücekutlu, 2015). Sucralose is a non-nutritive sweetener, which means it adds sweetness without calories. It makes it an appealing option for consumers looking to minimize their calorie intake while still enjoying sweetness (Morais Ferreira *et al.*, 2016), as well as other studies, including adding berries to chocolate.

(Lončarević *et al.*, 2018)Conducted a study on white chocolate with blackberry encapsulation using a 7-point scale (1 = lowest intensity and 7 = greatest intensity) with eight trained panelists. Consumers preferred the addition of blackberries due to the sour taste of the phenolic acid compounds, which play an essential role in the flavor profile) (Milošević, Milošević and Mladenović, 2019). Higher encapsulation levels resulted in higher consumer ratings.

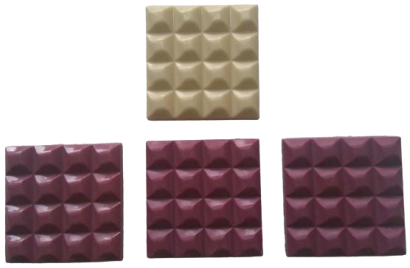

Figure 1.White chocolate as control and Chocolate with added blueberries

Blackberries produce a color due to anthocyanin pigments (Čechovičienė *et al.*, 2023), attracting consumer attention to chocolate added with blackberry encapsulation at high concentrations. Panelists like it less than chocolate without adding blackberries because it tastes the same.

Milk chocolate with the addition of berries, in the study of (Żyżelewicz *et al.*, 2021), with Organoleptic tests using the score test method has four treatments, namely, CONT = control chocolate, BLUB = Blueberries, RASB = raspberries, BLCB = blackberries, chocolate evaluated by trained panelists (8 people), the scoring test used five scales, 5 = very desirable quality to 1 = defective product. Based on panelist testing, the chocolate samples enriched with blueberry powder (BLUB) were highly preferred by the panelists during organoleptic evaluation. Sensory analysis showed that the chocolate with BLUB powder received the highest scores for various attributes, including appearance, aroma, flavor, and overall acceptability.

The expert panel was particularly impressed with the blueberry powder's enhanced flavor profile and distinctive fruity aroma. In contrast, the other samples, although still positively evaluated, did not reach the same level of preference as the sample enriched with blueberry powder (Żyżelewicz *et al.*, 2021), indicating that the inclusion of certain phenolic-rich plant powders can have a significant impact on consumer acceptance and sensory enjoyment of chocolate products. According to (Komes *et al.*, 2013), adding cranberry fruit also affects the sensory value of chocolate when compared to chocolate without the fruit.

III. Health Benefits of Chocolate with Berries

3.1 Cardiovascular

Research shows that chocolate containing cocoa has many benefits, as cocoa contains flavanols (Palma-Morales *et al.*, 2023). Flavanols are associated with improved cardiovascular outcomes, the flavanols group being cardioprotective (Razola-Díaz *et al.*, 2023). Numerous studies have shown that berry polyphenolic compounds benefit human health and reduce the risk of cardiovascular disease, type 2 diabetes, and cancer (Tavares *et al.*, 2012). The addition of berries can potentially produce chocolate products as functional foods.

3.2 Diabetes

Chocolate known for its cacao composition has many benefits; cacao and its flavonoids have been linked to several potential benefits for managing Type 2 diabetes (Ramos, Martín and Goya, 2017); regular intake of cocoa flavanols can improve insulin sensitivity, which is very important for controlling blood sugar levels (James I, 2015), the presence of flavonoids may also help regulate carbohydrate absorption and increase glucose uptake in peripheral tissues, thereby aiding better glycemic control (Kim, Keogh and Clifton, 2016), supported by berries content in research (Hameed *et al.*, 2020) showing that consumption of berries, their extracts, and purified compounds may indeed aid in the prevention and management of type 2 diabetes mellitus (T2DM) and its associated complications.

Berries contain polyphenols that boost insulin production, reduce apoptosis, promote pancreatic β-cell proliferation, regulate glucose metabolism, and increase peripheral tissue glucose uptake via insulin receptor-dependent or -independent pathways (Edirisinghe and Burton-Freeman, 2016). Berries' high antioxidant activity may also help treat chronic disorders linked to oxidative stress, such as diabetes, cardiovascular disease, and cancer (Jurikova *et al.*, 2017).

3.3 **Cancer**

Multiple studies have demonstrated that cocoa and chocolate products, which contain significant amounts of catechins, procyanidins, and other bioactive compounds, have advantageous health properties in combating oxidative stress, chronic inflammation, cancer, and other chronic ailments (Maskarinec, 2009).

Additional research has demonstrated that flavonoids found in chocolate and cocoa possess the capacity to reduce the likelihood of developing cancer in people. A mounting body of evidence substantiates the cancer-preventive properties of these substances (Greenberg *et al.*, 2021). Including berry extracts, freeze-dried berries like blueberries, bilberries, strawberries, and black raspberries, alongside chocolate, have demonstrated promising results in preventing cancer and inhibiting the growth of blood vessels (Zafra-Stone *et al.*, 2007). Epidemiological studies indicate that consuming a diet abundant in fruits, mainly berries, offers substantial health advantages in preventing some diseases, such as colon cancer (Afrin *et al.*, 2016).

IV. Conclusion

Chocolate is acknowledged as a functional food because of its bioactive constituents, such as polyphenolic antioxidants. Dark chocolate has a higher concentration of flavonoids than white chocolate, whereas goji berries and blackberries can augment its functional worth. Furthermore, these berries have the potential to enhance overall health by positively impacting cardiovascular health and reducing the risk of cancer.

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