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The influence of dried fruits enrichment on sensory properties of bitter and milk chocolates and bioactive content of their extracts affected by different solvents

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ABSTRACT

In this study the potential of utilizing five different kinds of dried fruits as additions for production of milk and bitter chocolates was evaluated. The bioactive content and antioxidant capacity affected by three different extraction solvents was determined, as well as the sensory properties of experimental chocolates. Both dried fruits and chocolates were characterized for their polyphenolic content and antioxidant capacity using UV/VIS spectrophotometric methods. In order to determine the phenolic profile, the content of total phenols and flavonoids, as well as the content of flavan-3-ols and proanthocyanidins was determined, while the antioxidant capacity was evaluated using ABTS (2,2-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid)) and FRAP (ferric reducing/antioxidant power) assays.

Compared to milk chocolate, bitter chocolate exhibited higher polyphenolic content, while in relation to plain ones, the addition of dried cranberries and raisins to chocolates contributed to the increase of total polyphenols. The results indicated that dried fruits are a rich source of polyphenolic antioxidants, which can, added to chocolate, enhance their antioxidant capacity and contribute to the dietary intake of polyphenolic antioxidants. According to the results of the sensory evaluation, the highest overall acceptability was recorded for bitter chocolate with dried apricots and milk chocolate with dried cranberries.

1. Introduction

The global consumption of chocolate confectionery is slowly increasing and has been estimated to 5.083 million tonnes in 2007 (CAOBISCO, 2007). The trend which is being promoted lately, according to specific consumer attitudes is the use of natural ingredients with preserved bioactive compounds and a high content of beneficial nutritive constituents. Confectionery products, especially chocolates have long been regarded as harmful due to the presence of high content of fat and sugar. However, the determination of polyphenolic antioxidants in cocoa and chocolate has broken the long lasting delusions about the adverse effects of chocolate. In European and American diet, cocoa solids represent a significant source of polyphenols (Vinson et al., 2006), which are discussed for being beneficial through their antioxidative activity (Ariefdjohan & Savaiano, 2005; Ding, Hutfless, Ding, & Girotra, 2006; Engler & Engler, 2006).

Accurate identification of bioactive compounds is essential to identify relationships between different food components and their health benefit. In addition, precise quantitation is necessary to determine dietary intake levels and safety guidelines for potentially bioactive compounds necessary to achieve desired health-beneficial properties (Luthria, 2006). The structural diversity of polyphenolic compounds makes the estimation of their content in food difficult, and the obtained values vary widely according to varieties, geographical origin, processing and other influences (Amiot, Tacchini, Aubert, & Nicolas, 1992; Hammerstone, Lazarus, Mitchell, Rucker, & Schmitz, 2000). Chocolate is a rich source of polyphenols, and a minor consumption of chocolate may significantly contribute to total polyphenol intake and more particularly to the catechin (Arts, Hollman, & Kromhout, 1999) and proanthocyanidin intake.

Nowadays, there are countless sorts and types of chocolate, starting from different cocoa solids content or the presence of milk in the chocolate, to a great variety of additions, fillings or aromatizing agents. So far, the majority of research has been conducted in order to study the influence of some bulk sweeteners (Lasekan, Ogunwolu, Hamzat, & Bamgbelu, 2007; Sokmen & Gunes, 2006), inulin (Golob, Mičović, Bertoncelj, & Jamnik, 2004) or milk type on

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the properties of chocolate (Belewu & Azeez, 2008; Ramli, Hassan, Said, Samsudin, & Idris, 2006). Although new approaches for the production of flavonoid-enriched products (Tomas-Barberan et al., 2007) have been reported, there is a lack of chocolates with natural and readily available additions such as dried fruits. Since a large portion of the produced fresh fruit cannot be consumed and does not meet the standards for exportation, these fruits can be preserved by air-drying thus providing an extension of shelf-life, minimising packaging and storage requirements, as well as transport costs. Dried fruits posses a characteristic flavour (Sabarez, Price, & Korth, 2000), and besides providing a rich source of sugar, also provide a high content of vitamins, minerals and polyphenols due to concentrated medium. Therefore the use of dried fruits in the production of chocolates is both economically and nutritively beneficial way to exploit the dried fruits.

In that way, a technologically demanding process of polyphenol extraction from a plant derived material would be avoided, while at the same time enabling the application of a wide range of dried fruits to be implemented in the chocolate production. The application of various dried fruits would additionally provide a wide spectrum of attractive flavours thus enhancing the taste of chocolate and possibly masking adverse and bitter taste of chocolates with a higher content of cocoa solids. The overview of the scientific literature reveals only one study regarding the sensory acceptance of filled chocolates with the addition of fruit pulp of strawberry, passion fruit and orange (Miquelim, Behrens, & Caetano da Silva Lannes, 2008). However, although there are commercially available chocolates aromatized with various fruit flavours, there are no studies on the polyphenolic content and antioxidative properties of chocolates enriched with dried fruits. This study therefore reveals the potential of utilizing readily available materials such as dried fruits as additions for producing confectionery products whose consumption provides a significant amount of bioactive compounds.

Therefore the aim of this study was to determine the influence of the addition of five different kinds of dried fruits on the polyphenolic content and antioxidant capacity of chocolates. Since milk chocolates are the most preferred chocolates among children, as well as among a high percentage of adults, and bitter chocolates are becoming a more popular part of the modern lifestyle, milk chocolate and bitter chocolate were evaluated for the possible changes after the addition of dried fruits. In order to compare the selected parameters, an array of rapid and reliable, widely used spectrophotometric methods were applied.

2. Materials and methods

2.1. Materials

2.1.1. Chemicals

Folin–Ciocalteu, formic acid, potassium peroxodisulfate, sodium carbonate, formaldehyde, ferric chloride hexahydrate, ferrous sulphate heptahydrate and hydrochloric acid were of analytical grade and supplied by Kemika (Zagreb, Croatia). Methanol (HPLC grade) was supplied by J.T.Baker (Deventer, Netherlands). Vanillin, 4-dimethylaminocinnamaldehyde, Trolox (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid), ABTS (2,2′-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid)diammonium salt) as well as gallic acid and cyanidin chloride were obtained from Sigma–Aldrich (Steinheim, Germany).

2.2. Methods

2.2.1. Preparation of chocolates

The addition of five different kinds of dried fruits purchased at a local market specialized for organic food (1 – prunes, 2 – papaya, 3 – apricots, 4 – raisins and 5 – cranberries) to milk (M) and bitter (B) chocolate was evaluated. Chocolate liquor was produced through a classical technological process in the confectionery factory (Zvečevo, Požega, Croatia).

Following formulations were used for the production of chocolates: bitter chocolate was made from 42 g/100 g of cocoa components (consisting of 31 g/100 g of cocoa liquor and 11 g/100 g of cocoa butter), 58 g/100 g of sugar and 4 g/100 g of Cocoa Butter Equivalent fat (CBE) (Illexao™ CB 40, Aarhus Karlshamn, Sweden), while for the manufacture of milk chocolate 34 g/100 g of cocoa components (consisting of 16 g/100 g of cocoa liquor and 18 g/100 g of cocoa butter), 50 g/100 g of sugar and 15.4 g/100 g of full cream milk powder were used. Cocoa butter was pre-melted by heating at 60 °C, and a part of the cocoa butter (to target total fat content of 25 g/100 g) was added to cocoa liquor, sugar and milk powder (for milk chocolate production) and mixed in a mixer (Carle & Montanari, Rozzano Milano, Italy). The mixture was refined in two phases: preliminary grinding on two-roll press (Carle & Montanari, Rozzano Milano, Italy) and grinding on five-roll press (Carle & Montanari, Rozzano Milano, Italy) to gain particle sizes ranging from 16 to 18 μm.

The conching phase was undertaken for a total of 24 h (dry conching for 4 h and liquid conching for 20 h) in a Carle & Montanari conch (Rozzano Milano, Italy). After 16 h of liquid conching, the remaining cocoa butter was added to achieve a target of 31 g/100 g fat in milk chocolate and CBE was added to achieve a target of 29 g/100 g fat in bitter chocolate. In both chocolate masses, 0.4 g/100 g of emulsifier (soy lecithin) and 0.02 g/100 g of vanilla flavour were added. The prepared chocolate masses were tempered in a SeedMaster tempering machine (Bühler, Uzwil, Switzerland). 2 kg portions of both chocolates were then excluded, and 20 g/100 g of the above mentioned dried fruits was added in laboratory conditions, followed by moulding into plastic moulds. The moulded chocolates were placed in a temperature-controlled room at 15 °C for 30 min before de-moulding and the finished bars were wrapped in aluminium foil and stored at 18 °C until analysed.

2.2.2. Preparation of chocolate extracts

Chocolate extracts were prepared as described by Guyot, Marnet, Laraba, Sanoner, and Drilleau (1998) and Hammerstone, Lazarus, Mitchell, Rucker, and Schmitz (1999), with some modifications. Cocoa liquor and chocolates were frozen and manually grated. In order to eliminate lipids from the samples, 2.0 g of each cocoa product was extracted three times with 10 ml of *n*-hexane. The defatted cocoa solids were air-dried during 24 h to remove the residual organic solvent (Adamson et al., 1999). The phenolic compounds were extracted two times from 2.0 g of defatted chocolates with 10 ml of distilled water, aqueous methanol (70 ml/100 ml) or aqueous acetone (70 ml/100 ml), for 30 min in an ultrasonic bath Elmasonic S120 (Elma, Singen, Germany). After each extraction, the mixture was centrifuged for 10 min at 1960× *g* and the supernatant was decanted. After filtration to remove the residual particles, the supernatants were combined in a flask and filled up to obtain 20 ml of extract. Dried fruits were extracted according to the same procedure (without prior defatting), in order to enable the comparison of the phenolic content and antioxidant capacity of chocolate and fruit extracts. The flask containing the extract was flushed with nitrogen prior to storage in a freezer at −18 °C.

2.2.3. Determination of total phenol (TPC) and flavonoid content (TFC)

Total phenol content (TPC) of chocolate or fruit extracts was determined spectrophotometrically according to a modified method of Lachman, Hosnedl, Pivec, and Orsák (1998). To determine