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Benefits of flavanol-rich cocoa-derived products for mental well-being: A review

Donald F. Smith[*]

Center for Psychiatric Research, Psychiatric Hospital of Aarhus University, Risskov, Denmark

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ABSTRACT

This review explores the possibility that central actions of flavanol-rich cocoa-derived products are of benefit in the prevention and treatment of mood disorders. Flavanol-rich cocao-derived products have been studied in both neuromolecular and psychological tests. Neuromolecular effects of flavanols in cocoa-derived products include antioxidant, vasodilatory, anticoagulant, and antiinflammatory properties that may serve to counteract depressive brain disorders. Psychological studies in humans have described links between intake of flavanol-rich cocoa-derived products such as dark chocolate and improved mood, while behavioral studies in laboratory animals have reported antidepressant effects of flavanols. It is therefore likely that flavanol-rich cocoa-derived products such as dark chocolate may have beneficial effects as add-on items together with traditional antidepressant regimes.

Contents

[*] Address: Center for Psychiatric Research, Psychiatric Hospital of Aarhus University, 8240 Risskov, Denmark. Tel.: +45 78463029.
E-mail address: dfsmithdfsmith@gmail.com

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1. Introduction

Mood disorders cause pronounced human suffering with severe consequences for families and society, and they are rapidly becoming the leading cause of disability worldwide (Greenberg et al., 2003; Wittchen et al., 2011). Mood disorders can lead to unemployment and prolonged disability, with 25–30% of patients never fully recovering, despite judicious selection and use of available treatments (Berlim, Fleck, & Turecki, 2008; Nemeroff, 2007). The need for innovations to minimize mood disorders continues, therefore, to stimulate interest in non-traditional add-on remedies, some of which include natural products (Sarris, Kavanagh, & Byrne, 2010; Sarris, Panossian, Schweitzer, Stough, & Scholey, 2011). A vast literature describes the potential health benefits of molecules found in natural products (Frost-Meyer & Logomarsino, 2012; John & Shahidi, 2010; Ramadan & Al-Ghamdi, 2012). Here, we focus attention on flavanol-rich cocoa-derived products such as dark chocolate, with special attention to their potential benefits in prevention and treatment of mood disorders.

2. Materials and methods

MEDLINE (PubMed) was searched in order to retrieve published reports answering to combinations of the following keywords: flavanol, chocolate, brain, depression, cocoa, cacao. The abstracts of articles listed by each search were read, and those with information of apparent relevance to the topic of the present review were downloaded. That procedure provided ninety-seven published reports, which served as the initial information base for the present review. As the writing of the review progressed, some of the articles were excluded due to their peripheral importance, whereas some other articles on secondary topics such as general aspects of neuropsychopharmacology were included.

3. Results and discussion

3.1. *Pharmacology of flavanols*

Cocoa contains particularly high quantities of phenolic phytochemicals known as flavanols (flavan-3-ols) (Aron & Kennedy, 2008; Lee, Kim, Lee, & Lee, 2003; McShea et al., 2008). The bioavailability of flavanols depends on numerous factors, including digestive release, absorption, metabolism, and elimination (Neilson & Ferruzzi, 2011; Spencer, Schroeter, Rechner, & Rice-Evans, 2001a; Spencer et al., 2001b). Briefly, absorption of flavanols is a multistep process, starting with their digestive release from foods and beverages. Next, flavanols are solubilized in the gut for uptake, transport, and passage via intestinal epithelia cells into the bloodstream. From there, flavanols are typically conjugated and/or methylated before acting on biological processes throughout the body (Keen, 2001; Urpi-Sarda et al., 2009). Flavanols readily cross the blood-brain barrier via stereoselective transport mechanisms and affect neuronal processes governing neurotransmission (Faria et al., 2011).

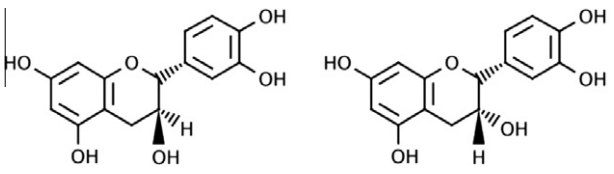

Fig. 1 – Molecular structure of (+)-(2*R*,3*S*)-catechin (on left) and (−)-(2*R*,3*R*)-epicatechin (on right) (Aron & Kennedy, 2008; Birch, Clark-Lewis, & Robertson, 1957).

Studies on pharmacological effects of flavanols have revealed central antioxidant, antiinflammatory, and vasodilatory actions that depend highly on steric molecular features (Aron & Kennedy, 2008; Bravo, 1998; Engler & Engler, 2006; Maes, 2008, 2011; Nishida, Miyaoka, Inagaki, & Horiguchi, 2009). Thus, two stereoisomers, (2*R*,3*S*)-catechin and (2*R*,3*R*)-epicatechin (Fig. 1), are present in the diet and provide the building blocks of polymeric flavanols known as proanthocyanidins (Gu, House, Wu, Ou, & Prior, 2006; Miller et al., 2006). Catechin and epicatechin are readily detected in the bloodstream after their consumption, whereas large, polymeric flavanols may be less readily absorbed from the gastrointestinal tract (Fernandes, Nave, Goncalves, & Mateus, 2012).

3.2. *Psychology of chocolate*

Chocolate has attracted much attention in psychological science. Chocolate is often consumed in pleasant situations such as when youngsters receive a piece for being well-behaved, and most people like the taste of chocolate and the way it melts in their mouth (Michener & Rozin, 1994; Parker & Crawford, 2007; Parker, Parker, & Brotchie, 2006). Studies carried out in laboratory animals have also shown chocolate to be a strongly rewarding substance, since they will work very hard to obtain it (King, Isaacs, O'Farrell, & Abizaid, 2011). One explanation for the potent rewarding properties of chocolate comes from the age-old notion of "the wisdom of the body" (Cannon, 1932), which views cravings for specific nutrients as being driven by internal physiological needs required by homeostatic mechanisms. According to such a view, craving for chocolate would reflect a physiological bodily need for an ingredient in chocolate that is required for maintaining health. However, humans are notoriously poor at responding properly to bodily nutritional requirements (Hetherington & Macdiarmid, 1993; Thomson & Ravia, 2011; Waters et al., 2011), which makes it unlikely that physiological factors are mainly responsible for craving of an "emotionally-charged" food such as chocolate (Hormes & Rozin, 2011; Rodin, Mancuso, Granger, & Nelbach, 1991). A more likely explanation notes that chocolate intake often reflects "pleasure-seeking" behavior directed at sensory gratification (Macdiarmid & Hetherington, 1995; Macht & Dettmer, 2006; Macht & Mueller, 2007; Parker & Crawford, 2007; Tuomisto et al., 1999). Thus, psychological factors appear to have a marked influence on chocolate consumption.

Some recent studies in psychology have been carried out in healthy subjects to determine whether intake of flavanols in cocoa-based beverage can improve performance in demanding tests of cognitive functions. In one study, subjects received one of three doses of flavanols on the day of tests (Scholey et al., 2010). In that study, the subjects that received the high-dose flavanol beverage showed enhanced performance in terms of reaction times, response rates, and