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Effects of saffron extract and crocin on anthropometrical, nutritional and lipid profile parameters of rats fed a high fat diet

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ABSTRACT

Overweight and obesity are the most common nutritional disorders in the world. The aim of this study was to evaluate anti-obesity effects of ethanolic extracts of saffron and crocin in comparison to orlistat in animal model. Male Sprague Dawley (SD) rats were fed high-fat diet (HFD) for 12 weeks to induce obesity. The saffron extracts (40 and 80 mg/kg), crocin (40 and 80 mg/kg) and orlistat (20 mg/kg) were fed to rats by mixing with high fat diet (HFD) for 8 weeks. Changes in anthropometrical, nutritional and lipid profile parameters were measured. The saffron extract significantly decreased food consumption in obese rats. Crocin (80 mg/kg) showed a significant decrease on rate of body weight gain, total fat pad and weight ratio of epididymal fat to body. Furthermore, crocin (80 mg/kg) significantly reduced plasma levels of triacylglycerol (TG) and total cholesterol (TC) while saffron extract (40 mg/kg) showed major improvement in low-density lipoprotein to high-density lipoprotein (LDL/HDL) level as atherogenic index. These findings demonstrated the potential anti-obesity benefits of saffron extract and crocin in preclinical study.

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1. Introduction

Obesity is expected to emerge as a major cause of morbidity and mortality globally (WHO, 2009). In 2008, more than 1.4 billion adults were identified as being overweight and of that figure at least 200 million men and almost 300 million women were considered obese (WHO, 2009). Obesity is a worrying epidemic as it significantly increases the risks of developing other potentially life threatening diseases, such as type II diabetes, hypertension, coronary heart disease, stroke and certain cancers (WHO, 2009). Obesity is determined by factors such as satiety control, reduced levels of physical activity aside from hormonal and genetic factors; the latter significantly affect the metabolic pathways leading to an increase in stored fat (Jeffcoat, 2007).

The pharmacotherapy of obesity has also undergone extensive changes. Important barriers that adversely affect long-term obesity management include lack of tailored obesity training of health professionals, prevailing attitudes, and mindsets as well as safeguard and availability of obesity treatments (Kirk, Penney, McHugh, & Sharma, 2011). The market for anti-obesity drugs has increased quite rapidly but the available drugs are extremely scarce in relation to need. Thus, it is paramount that researchers investigate for novel anti-obesity drug. The main therapeutic strategies for tackling obesity are diet control and physical exercise or fitness. In recent years, natural products or dietary phytochemicals have garnered much interest as potential therapeutic agents to counter obesity (Baboota et al., 2013; Hasani-Ranjbar, Larijani, & Abdollahi, 2009; Moro & Basile, 2000; Rayalam, Della-Fera, & Baile, 2008). These compounds utilise anti-obesity property by regulating lipid absorption, intake and expenditure of energy, decrease lipogenesis and increase lipolysis, and differentiate the proliferation of pre-adipocytes (González-Castejón & Rodriguez-Casado, 2011).

Saffron, *Crocus sativus* L., belongs to the Iridaceae family, and is a common plant widely cultivated in Iran, Spain, Greece and India. Over the last two decades, saffron has been recognised as a spice that possesses many therapeutic properties. There is mounting evidence that saffron has potential anti-obesity effect (Mashmoul, Azlan, Khaza'ai, Yusof, & Noor, 2013). Currently in the market, there is an anti-obesity product containing saffron as the main ingredient that touted as a satiety suppressant and weight loss promoter. Saffron is a rich source of carotenoids (crocin), glycoside (picrocrocin) and a volatile oil component (safranal) (Fernández & Pandalai, 2004; Winterhalter & Straubinger, 2000). Crocin (Crocetin digentiobiose ester) is considered one of the major bioactive constituents and has a wide spectrum of biological activities including antigenotoxic and cytotoxic effects (Abdullaev, 2002, 2003, 2006; Abdullaev et al., 2003; Gutheil, Reed, Ray, Anant, & Dhar, 2012), antioxidant (Assimopoulou, Sinakos, & Papageorgiou, 2005; Charles, 2013; Chen et al., 2008; Kanakis, Tarantilis, Tajmir-Riahi, & Polissiou, 2007; Papandreou et al., 2006; Verma & Bordia, 1998), antinociceptive and anti-inflammatory (Hosseinzadeh & Younesi, 2002; Poma, Fontecchio, Carlucci, & Chichiricco, 2012), anti-atherosclerosis (He et al., 2005, 2007; Kamalipour & Akhondzadeh, 2011), anti-diabetic (Hirali, Zahra Bathaie, & Nakhjavani, 2012; Plants & Karaj, 2009; Xi, Qian, Shen, Wen, & Zhang, 2005), hypotensive (Imenshahidi, Hosseinzadeh, & Javadpour, 2010), hypolipidaemic (Sheng, Qian, Zheng, & Xi, 2006), hypoglycemic (Mohajeri, Mousavi, & Doustar, 2009; Plants & Karaj, 2011), antidepressant (Akhondzadeh et al., 2005; Basti et al., 2007; Hosseinzadeh, Karimi, & Niapoor, 2003; Hosseinzadeh, Sadeghnia, Ghaeni, Motamedshariaty, & Mohajeri, 2012; Noorbala, Akhondzadeh, Tahmacebi-Pour, & Jamshidi, 2005) and satiety enhancer (Gout, Bourges, & Paineau-Dubreuil, 2010). Although numerous studies have examined the different medicinal properties of saffron and its constituents, saffron, however, has not been investigated for its anti-obesity potential. We used a rat model and fed it a high fat diet to induce obesity. This is based on experimental studies which indicated that high-fat diets are known to increase weight and fat mass, alter carbohydrate and lipid metabolism levels leading to pathogenesis of obesity in humans, rodents, and other animals. Hence, this study aims to evaluate anti-obesity effect of saffron's ethanolic extract and its pure bioactive compound crocin in a model of high fat diet–induced obesity.

2. Material and methods

2.1. Plant and chemicals

The saffron used in this study was provided by Saman Khoshe Toos Co. (Mashhad, Iran). The crocin powder was purchased from *Sigma*-Chemical Co. (St. Louis, MO, USA). Orlistat (Xenical) was purchased from a local pharmacy.

2.2. Preparation of plant extract

We used the maceration method to soak 10 g of saffron stigmas in 500 ml ethanol (80%, v/v) for 3 days. The mixture was filtered and concentrated under reduced pressure at 40 °C. The concentrated powder was obtained using the freeze drying process. The extract yield was 50% (w/w).

2.3. HPLC analysis of the saffron extract

The main characteristics of the saffron extract related with crocins and safranal content were determined using high performance liquid chromatography (HPLC) analysis. The liquid chromatography comprised of a Model 600 E Waters pump (Waters Association, Milford, MA, USA), a variable wavelength, model 484 Waters UV detector, a U6K Waters sample injection system and ODSA C_{18} (4.6 × 250 mm, 5 μm) column (YMC, Dinslaken, Germany). The data analysis was done by Autochro-2000 (Younglin, South Korea). The injection volume and flow rate were 20 μL and 0.5 mL min^{-1}, respectively. A gradient method was used for chromatographic determination of crocins (λ_{max} = 440 nm) which the mobile phase composition was changed from 20 to 80% acetonitrile in water for 20 min. For analysis of safranal (λ_{max} = 308 nm), an isocratic method was used. The composition of mobile phase was 76% acetonitrile in water (Hadizadeh et al., 2010).

2.4. Animals and diets

The ethics committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia (UPM) approved the