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Preparation and Evaluation of Dietetic Cookies for Vulnerable Segments Using Black Cumin Fixed Oil

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Abstract: Varying consumption trends and poor dietary habits had led to widespread prevalence of various lifestyles related disorders including obesity, diabetes and dyslipidemia. The reliance of communities on processed foods is also detrimental factor in their progression. The concerted efforts are required in order to eliminate these problems. In this project, efforts were directed to prepare nutritious dietetic cookies using Black Cumin Fixed Oil (BCFO). Accordingly, formulations of cookies were modified to reduce the fats, sugar and energy level along with provision of some bioactive molecules from BCFO. The results indicated that reduction in fat and sugar levels provided less calorific value to cookies. However, utilization of BCFO (~4%) resulted in some quality retention even at reduced levels of fats and sugars. Furthermore, reducing the level of shortening and sugars resulted in decreased fat contents (45.61%) as compared to control. Similarly, total sugar levels were decreased by 43.17%. These cumulative factors led to dwindled calorific value by 37.98%. The reduction in fats and sugars led to decreased sensory appraisal from trained taste panel. However, at 40% reduction in fats and sugars were quite acceptable owing to presence of BCFO. It further provided protection against lipid per-oxidation as indicated from peroxide value. In the nutshell, preparation of nutritious and dietetic cookies using BCFO is feasible approach to reduce the calorific value of cookies and such novel products hold potential to reduce the obesity and related disorders.

Key words: *Nigella sativa*, flour blends, nutritional profile, functional properties

INTRODUCTION

In the last few decades, the dietary patterns have changed owing to industrialization coupled with reliance of the communities on processed foods. The outcomes include obesity, diabetes mellitus and cardiovascular disorders (Butt *et al*., 2009). Among these, obesity is widespread not in developed economies but also in developing countries like Pakistan. The obesity and overweight is linked to higher intake of energy dense baked and junk foods and closely associated with onset of lifestyle related maladies. Some other factors like lack of physical exercise are also responsible for these disorders however dietary regimens are of critical consideration (Hensrud, 2004). In the United States, approximately 62% of the adult population is classified as overweight and more than half of the overweight people are classified as obese. Similarly, incidence of obesity in the majority of European countries has increased by 10-50% in the last ten years. In Pakistan, statistics are also alarming as most of children belonging to the urban areas are obese and percentage reported in early interventions varies from 15-56% (Wildman and Kelley, 2007).

The consumption of foods rich in fats and sugars like biscuits, cakes, chips and etc. are also an important cause of dyslipidemia; more prevalent in obese people. Such foods result in increased total cholesterol, Low-Density Lipoprotein (LDL) and triglycerides. Likewise, obesity is also linked with onset of diabetes mellitus and its complications (Furukawa *et al*., 2004). Pakistan is at 6th number in diabetic patients and expected to cross Japan in 2030 (Wild *et al*., 2004). Quest for ease in food choice is mainly held to be the focal reason behind this entire nuisance. Adopting energy rich dense and junk foods are believed to be responsible for further worsening of this catastrophic situation. This awful condition created by diet linked maladies has severely put human health under question (Butt and Sultan, 2009; Jacobs-Jr. *et al*., 2009).

Sincere efforts have been made by nutritionists and health care officials aimed at spreading awareness in masses regarding health benefits of foods (Krystallis *et al*., 2008). As a result, nowadays consumers are more concerned to healthy foods selection that resulted in development of diversified food market. However, the natural products and their incorporation in products were main focus (Klein *et al*., 2000; Ramaa *et al*., 2006; Zock and Katan, 2008; ADA, 2009). The health supporting attributes of these foods are mainly owned to the presence of bioactive compounds like catechins,

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sulforaphane, anthocyanins, polyphenols, isothiocyanates, carotenoids, fibers, essential oils, etc. (Wang *et al*., 2009; Roy *et al*., 2010; Shabir *et al*., 2010). It has been widely agreed that people consuming diet rich in functional/bioactive components are at lower risk of chronic illnesses thus reducing the risk of mortality (Jew *et al*., 2009; Siro *et al*., 2008). The black cumin is important in this regard as it is rich in bioactive molecules and hold potential to reduce the obesity and related health disorders (Cheikh-Rouhou *et al*., 2007; Sultan *et al*., 2009a; Butt and Sultan, 2010). It is the need of the hour to reduce the energy intake of the communities along with addition of health promoting components in foods primarily to improve the nutritional value. Keeping in view the lifestyle disorders, present project was designed to prepare the dietetic cookies with reduced fats and sugar contents. Moreover, the utilization of black cumin fixed oil will bolster the nutritional value of the product by providing bioactive molecules. Concurrently, preparation of novel products with reduced calorific value and improved phytochemical density was the limelight of the present research investigation. The present research project explored the industrial application of black cumin fixed oil for the preparation of value added food products.

MATERIALS AND METHODS

Black cumin seeds of indigenous variety were obtained from Barani Agricultural Research Institute (BARI), Chakwal. Raw materials for cookies preparation were procured from local market while reagents (analytical and HPLC grade) and standards were purchased from Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan) and Merck (Merck KGaA, Darmstadt, Germany).

Extraction and analysis of fixed oil: The oil from the black cumin seed was extracted through solvent (n-hexane) extraction system as described in AOCS (1998). n-Hexane was recovered by Rotary Evaporator (Eyela, Japan). The results regarding physical and chemical analysis of black cumin oil has been already published (Gali-Muhtasib *et al*., 2004; Sultan *et al*., 2009b).

Product development: Cookies were prepared using method given in AACC (2000) with some modifications. The levels of fats and sugar were gradually from 250 grams each to 100 grams in recipe for preparing one kilogram of cookies. The BCFO was used @ 50 g/kg in all cookies formulations. The detailed treatment plan is described in Table 1. As far as preparation of cookies is concerned, initially shortenings and sugar were mixed in Hobart Mixer-N50 (Hobart Manufacturing Co., Troy, Ohio, USA), followed by the addition of eggs. The wheat flour and baking powder were mixed separately and added to a creamy mass. The process of mixing was repeated again till homogenous mass i.e. batter that was further rolled and cut with the help of a biscuit cutter. The cookies were baked at 425°F in the baking oven for 15-20 min. After baking, the cookies were cooled and hermetically packed in aluminum foils.

Table 1: Treatment plan for the preparation of nutritious dietetic cookies

Treatments	Wheat (g)	Black cumin fixed oil (g)	Shortenings (g)	Sugars (g)
T_0	500	50	200	250
T_1	600	50	200	250
T_2	600	50	175	225
T_3	600	50	150	200
T_4	600	50	125	175
T_5	600	50	100	150
T_6	600	50	75	125
T_7	600	50	50	100

*The other ingredients like baking powder, flavors and eggs remain constant. **The black cumin fixed oil was used @ 4% of the recipe

Physical analysis of cookies: The cookies were analyzed for diameter, width and spread factor according to method as described in AACC (2000). For the purpose, six cookies were placed horizontally and vertically to calculate the diameter and width, respectively. Spread factor was calculated according to the formula i.e. SF = (W/T) x 10 (Sharif *et al*., 2005).

Chemical analysis: Cookies were analyzed for proximate composition; moisture (Method No. 44-15A), ash (Method No. 08-01), protein (Method No. 46-30), fat (Method No. 30-25), fiber (Method 32-10) and nitrogen free extract according to their respective methods (AACC, 2000). Total sugars were also determined using the procedures detailed in AOAC (2003). The calorific value of cookies was evaluated using simple calculations.

Oxidative stability of cookies: Oxidative stability of cookies was estimated by determining peroxide value as described in AACC (2000).

Sensory evaluation: The cookies were rated against 9-point hedonic score system (9 = like extremely; 1 = dislike extremely) by trained taste panel (Meilgaard *et al*., 2007). The panelists were briefed about the dietetic product and taste of BCFO. During sensorial evaluation, cookies with different oil compositions were placed in transparent cups, labeled with random codes. Cold water and crackers were supplied to panelists for rinsing their mouths between the samples. In each session, panelists were seated in separate booths equipped with white fluorescent lighting in an isolated room. The cookies were presented in random order and panelists were asked to express their opinion about the end product by giving score to attributes like color, flavor, taste, texture and overall acceptability.

Statistical analysis: Data obtained was analyzed statistically using statistical package i.e. Cohort V-6.1 (Co-Stat-2003). Analyses were run triplicate and values presented in Tables are Means ± Standard Deviation (SD). Additionally, analysis of variance technique was applied to determine the level of significance. The significant differences among means were further compared using Duncan's Multiple Range test (DMRt) following the methods described by Steel *et al.* (1997).

RESULTS AND DISCUSSION

In the present project, the dietetic cookies were prepared using the reduced levels of fat and sugar. The Black Cumin Fixed Oil (BCFO) was also used to improve the phytochemicals density of the cookies. The dietetic cookies were evaluated for physical and chemical characteristics. The results pertaining to physical attributes (Table 2) indicated that reducing the level of shortenings and sugars reduced the diameter of cookies from 9.99±0.50 cm to 10.82±0.64 cm. On contrary, the width of cookies showed significant declining tendency; the cookies prepared with normal recipe (control) showed the highest diameter of 44.10±2.71 cm followed by T_1 (43.90±2.65 cm), whilst least diameter was observed in T_7 (33.81±2.19 cm) that was statistically at par with T_6 with mean diameter of 33.96±2.56 cm. The spread factor is dependent upon the values of diameter and width of the cookies. In this instant study, spread factor was reduced from 44.55±1.36 to 31.25±1.40 owing to reduced levels of shortenings and sugars. The preparation of cookies requires the process of creaming followed my mixing of flour and other dry ingredients. The reduction in shortenings and sugars results in hard batter that is one of main reasons for increased diameter of cookies along with reduction in width of the cookies. The spread ability of cookies is also dependent upon the hard or soft batter formed during mixing (Gaines and Donelson, 1985). The results are in close proximity with Sharif *et al.* (2009), they reported that addition of rice bran results in formation of hard batter thus cookies prepared were of increased diameter and reduced width. The present results are comparable with some other research interventions pertaining to cookies formulations that include studies conducted by Pasha *et al.* (2002), Arshad *et al.* (2007). Some minor differences from some previous studies are ought to addition of BCFO as vegetable oil inclusion in cookies formulation enhances the width and decrease the diameter of cookies. As a general rule, differences in soft and hard batter are major contributory factors for significant variations in physical attributes of cookies.

Table 2: Physical characteristics of nutritious dietetic cookies

Treatments	Diameters	Width	Spread factor
T_0	09.99±0.50	44.10±2.71	44.55±1.36
T_1	10.08±0.48	43.90±2.65	43.55±1.27
T_2	10.21±0.22	40.42±2.62	39.59±0.58
T_3	10.35±0.60	39.04±2.43	37.72±1.46
T_4	10.46±0.49	37.28±2.42	35.64±1.19
T_5	10.50±0.52	35.89±3.06	34.18±1.59
T_6	10.76±0.44	33.96±2.56	31.56±1.13
T_7	10.82±0.64	33.81±2.19	31.25±1.40

The results regarding the estimation of chemical attributes of cookies are presented in Table 3. The results indicated that moisture contents were affected non-significantly and values were in the range of 2.42±0.12 to 2.80±0.24%. As far as proteins are concerned, the increasing tendency was observed with the reduced levels of shortenings and sugars. Maximum contents were recorded in T_7 (9.98±0.50%) followed by 9.38±0.55% in T_6. Whereas, least protein contents of 6.83±0.34% were observed in dietetic cookies prepared with standard recipe (control). Likewise, fiber and ash contents were increased from 0.56±0.03 to 0.85±0.08% and 1.97±0.14 to 2.25±0.16%, respectively. In contrary, reducing the levels of shortenings and sugars resulted in significant decrease in fats and sugar contents of cookies. The results pertaining to fats contents of cookies indicated declining tendency and maximum fats contents of 25.60±0.64% was observed in control as compared to least contents of 13.92±0.48% in T_7. Similarly, sugar contents were the highest in control (26.12±1.51%) as compared to the lowest in T_7 (14.85±0.91%). Consequently, the data related to calorific value of cookies indicated that reduced levels of shortenings and sugars resulted in significant decrease in the said parameter. The cookies prepared with normal formulation (control) showed higher calorific value of 362.20±4.14 KJ/100gm. However, reducing the shortenings and sugar levels resulted in decreased calorific value and least value were observed in T_7 (224.63±10.07 kcal/100 gm) followed by T_6 (249.24±10.60 kcal/100 gm). The chemical characteristics of cookies are attributed to ingredients used in the recipe. In this regard, Bordes *et al.* (2008) reported the chemical composition of different cultivars of wheat. The reasons pertaining to variations in chemical attributes in the instant study are simple to explicit. The reduced levels of shortening and sugars in cookies formulations are manifested in final products. Therefore, results are in accordance with the results of Arshad *et al.* (2007), Sharif *et al.* (2009) and Pasha *et al.* (2002). The cookies are considered as an important source of macronutrients and energy especially for children and adolescents (Mahmood *et al.*, 2008).

Table 3: Chemical characteristics of nutritious dietetic cookies

Treatments	Moisture	Protein	Fats	Fiber	Ash	Sugars	Colorific value	Peroxide value
T_0	2.56±0.13	6.83±0.34	25.60±0.64	0.56±0.03	1.97±0.14	26.12±1.51	362.20±04.14	0.189±0.005
T_1	2.42±0.12	7.20±0.35	23.60±0.56	0.61±0.05	1.90±0.13	24.26±0.57	338.18±05.87	0.206±0.007
T_2	2.43±0.05	7.55±0.39	22.38±0.26	0.64±0.01	1.95±0.07	23.08±1.29	323.92±06.38	0.192±0.012
T_3	2.54±0.15	7.93±0.39	21.02±0.65	0.67±0.02	1.99±0.18	21.75±1.07	307.89±04.11	0.178±0.011
T_4	2.56±0.12	8.36±0.43	19.53±0.51	0.71±0.03	2.05±0.23	20.31±0.98	290.46±07.66	0.178±0.015
T_5	2.80±0.24	8.82±0.59	17.84±0.44	0.75±0.02	2.10±0.16	18.65±1.41	270.42±09.03	0.165±0.011
T_6	2.60±0.11	9.38±0.55	16.02±0.65	0.80±0.05	2.18±0.08	16.89±1.31	249.24±10.60	0.171±0.019
T_7	2.63±0.16	9.98±0.50	13.92±0.48	0.85±0.08	2.25±0.16	14.85±0.91	224.63±10.07	0.182±0.019

Table 4: Sensory attributes of nutritious dietetic cookies

Treatments	Color	Flavor	Taste	Texture	Appearance	Overall acceptability
T_0	8.20±0.40	7.27±0.53	7.80±0.45	7.80±0.24	7.72±0.19	7.48±0.22
T_1	8.12±0.42	7.30±0.54	7.62±0.18	7.78±0.25	7.69±0.26	7.43±0.20
T_2	7.93±0.32	7.40±0.28	7.52±0.42	7.62±0.15	7.56±0.46	7.20±0.56
T_3	7.68±0.39	7.42±0.47	7.49±0.37	7.49±0.10	7.51±0.45	7.18±0.62
T_4	7.38±0.57	7.29±0.48	7.28±0.35	7.20±0.19	7.24±0.62	7.09±0.49
T_5	7.25±0.26	7.08±0.61	6.89±0.52	6.89±0.23	7.08±0.49	6.65±0.49
T_6	6.25±0.38	6.08±0.50	6.21±0.48	5.92±0.38	6.38±0.72	5.48±0.52
T_7	5.20±0.51	5.69±0.41	5.20±0.32	4.21±0.32	4.38±0.45	4.01±0.61

The inclusion of natural products in food products provides multifarious objectives. On one hand they infer phytochemicals to the products, while they are also associated with improved shelf life. The inclusion of BCFO @ 50 g/kg resulted in reduced peroxide value as compared to some previous reported values in the literature. In the present research, peroxide value varied from 0.165±0.011 to 0.206±0.007 meq/100 gm. The peroxide value is an indicator of rancidity and during baking shortening underwent oxidation and thermal degradation. However, presence of BCFO as a source of natural antioxidants prevented the process of oxidation thus reducing the peroxide value of the final produce.

The results regarding the sensory attributes (Table 4) indicated that color decreased with 8.20±0.40 in control followed by T_1 (8.12±0.42), whilst least color scores were recorded in T_7 (5.20±0.51). Similar pattern of scores were recorded for taste and texture as mean scores decreased from 7.80±0.45 to 5.20±0.32 and 7.80±0.24 to 4.21±0.32, respectively, due to reduction in fats and sugar levels. Moreover, appearance of cookies also decreased as maximums scores for this trait were recorded in control (7.72±0.19) that was statistically at par with T_1 (7.69±0.26), whereas lowest scores for appearance was recorded in T_7 (4.38±0.45). The cookies prepared with reduced levels of shortenings and sugars i.e. 125 g and 175 g, respectively, with mean scores of 7.09±0.49 that was statistical at par with cookies (150 g shortening and 200 sugars). The cookies prepared with reduced level of shortening (100 g) and sugars (150 g) also rated better on hedonic scale with mean score for overall acceptability of 6.65±0.49. In the nutshell, dietetic cookies prepared with 40% reduction in shortenings and sugars each rated acceptable. Results of present investigation are close association with the results of Pasha *et al.* (2002). However according to best of author knowledge, the present study is first to explore the utilization of black cumin fixed oil in dietetic cookies to improve the phytochemicals dense cookies.

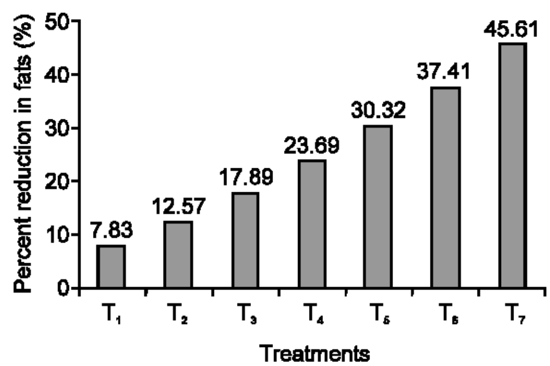

Fig. 1: Effect of cookies formulation on percent reduction in fats contents of cookies

In the last, graphical depiction has been made to briefly discuss the percent reduction in fats, sugars and calorific values in dietetic cookies. The reduction in level of shortening and sugars resulted in reduced fat contents of cookies and maximum reduction was observed in T_7 (45.61%), however, at acceptable level of shortening and sugar levels i.e. 100 and 150 g, respectively, the fat contents decreased by 30.32% (Fig. 1). Likewise, reduced sugar contents of cookies were observed with changes in cookies formulation. Maximum sugar reduction was observed in T_7 (43.17%), however, at acceptable level of shortening and sugar levels as described earlier the sugar contents decreased by 28.59% (Fig. 2). The calorific value of cookies decreased in the range of 6.63-37.98% in dietetic cookies. Maximum reduction was achieved in T_7 however at 100 g shortening and 150 g sugars the calorific values decreased by 25.34%.

The similar reduction was achieved with artificial sweeteners by Pasha *et al.* (2002). In the nutshell, utilization of black cumin fixed oil @ 50 g/kg can be

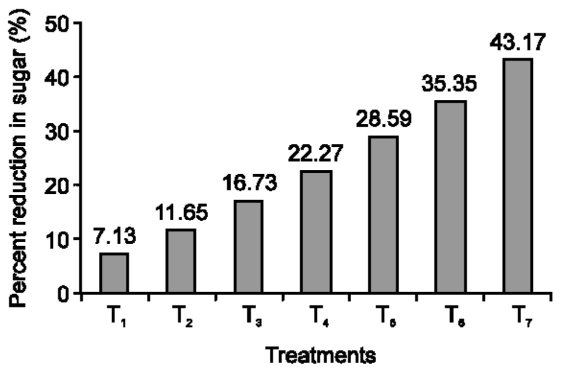

Fig. 2: Effect of cookies formulation on percent reduction in sugars contents of cookies

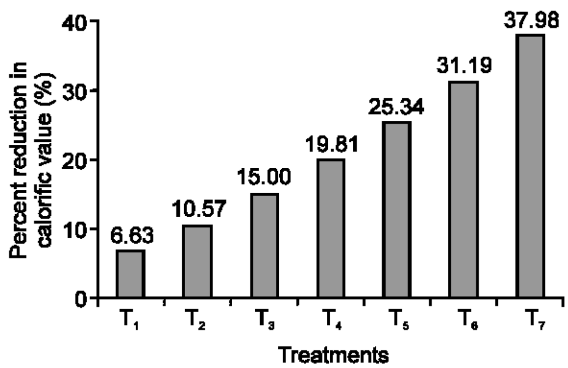

Fig. 3: Effect of cookies formulation on percent reduction in calorific value of cookies

helpful in the production of dietetic cookies with better acceptability from consumers with reduction of 45.61, 43.17 and 37.98% in fat and sugar contents and calorific value, respectively.

Conclusion: It is concluded from the overall results that black cumin fixed oil is nutritious and wholesome ingredient for supplementation in cereal based products. Moreover, it can be utilized in the production of dietetic cookies to improve the consumer acceptability. In the nutshell, utilization of black cumin fixed oil @ 50 g/kg can be helpful in the production of dietetic cookies with better acceptability from consumers with reduction of 45.61, 43.17 and 37.98% in fat and sugar contents and calorific value, respectively. BCFO can be used to enhance the phytochemicals density of food products and can be used for the alleviation of obesity and related health disorders.

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