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Development of Cookies Using Fenugreek Seed Extract as a Functional Ingredient

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Abstract

Cookies were developed with fenugreek seed extract and fenugreek seed powder (FSP) as an added-value food ingredient with wheat flour. Fenugreek seed extract were encapsulated using g**um arabic**. Their physical and sensory analysis was studied. Results showed significant ($p<0.05$) difference of physical properties between control and 1-4% FSP level and 1-2% encapsulated fenugreek seed extract level. Spread ratio was found highest for those cookies where substitution was made with encapsulated fenugreek seed extract. Fracture strength was highest for 4% level of FSP, whereas encapsulated fenugreek seed extract levels showed average value of fracture strength. Sensory analysis report showed highest score for the cookies, where substitution was made with 1-2% encapsulated fenugreek seed extract, which was close to control, as compared to 1-4% FSP levels. It can be concluded that these desirable properties of cookies contained with fenugreek seed extract suggested that fenugreek seed extract can be used further in the development of quality cookies. Fenugreek seed extract possessing lot of physiological health benefits like hypoglycemic effect, hypocholestrolemic effect, possessing antioxidant activity etc. and could have higher preference over the whole seed powder of fenugreek for development and acceptability of cookies.

Keywords: Fenugreek; Cookies; Physical Properties; Sensory Properties; Encapsulation.

Introduction

Fenugreek *(Trigonella foenum-graecum)* commonly known as "methi" is an annual herb of the Leguminosae family and is grown mainly in Western Asia and South Eastern Europe. India is the largest producer and the major producing states are Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Uttrakhand, Madhya Pradesh and Punjab. Both the fresh and dried leaves as well as the seeds are edible. These are used as herb, spice and vegetable. Fenugreek seeds are small having a peculiar odor, flavor and pleasantly bitter taste and are used as spice in India, China and Middle East for centuries. Fenugreek endosperm contains the highest amount of saponins (4.63 g / 100 g) and protein (43.8g / 100g) and the husk has highest polyphenol content [1]. Fenugreek seeds are known to have several pharmacological effects such as hypoglycemia [2, 3], hypocholesterolemia [4, 5], gastro-protective [6], chemopreventive [7], anti-oxidative [8], anti-inflammatory, antipyretic [9], laxative [10] and appetite stimulation attributes [11]. Fenugreek has been found to have protective effect on acute cerebral ischemia [12]. Also it has beneficial influence on digestion and also has the ability to modify food texture [13].

The bitter taste and distinct aroma of fenugreek seed limit its wider application in the food industry**.** *As bread found to be the most universal of all bakery products,* **its** fine texture, and large loaf volume require formation of an elastic dough structure. That is possible only due to presence elements possessing gluten. Gluten is present in hard wheat (12% protein). Large quantities of bakery products are consumed daily. However addition of fenugreek seed powder to wheat flour in different proportions increased the lysine, minerals, protein and dietary fibre contents proportionately to the level of substitution. Also the products, viz., noodles, biscuits, bread and macaroni prepared from the wheat–fenugreek blends at 10, 15,

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and 20% levels were found organoleptically acceptable. Fenugreek has been used earlier in bakery products such as biscuits [14] and extruded products [15].

Cookies have been suggested as a better for the carrier of fenugreek because of its relatively sweet taste, wide consumption, relatively long shelf-life and good eating quality as compared to other similar products [16]. Cookies with high sensory ratings have been produced from blends of millet / pigeon pea flour [17], green gram, Bengal gram, black gram and wheat [18], groundnut, cowpea and wheat [19] and soybean, chickpea or lupine with wheat [20]. No reports of studies were found for combinations of Wheat and fenugreek seed powder (FSP) and fenugreek seed extract. Cookies can provide a convenient vehicle for delivery of health-promoting compounds possessed in fenugreek to consumers. The aim of the present research work involves the use of fenugreek seed extract for the development of cookies with several health benefits and study the effects of fenugreek extract on cookies in terms of physical and sensory characteristics.

Materials and Methods

The study was carried out in the Department of Food Engineering and Technology, Sant Longowal Institute of Engineering and Technology, Longowal, Punjab. The extraction of dried and ground fenugreek seeds for bioactive component was done using ultrasound assisted extraction (UAE) and microwave assisted extraction (MAE) techniques. The extracts were encapsulated and utilized in cookies preparation.

Procurement of Raw Material

Fenugreek seeds of variety HM-57 were purchased from Haryana Agricultural University (HAU), Hisar, Haryana. The seeds were then inspected and cleaned manually to remove any foreign material, dirt, stones, grits, weeds etc. Ground fenugreek seeds were extracted using ultrasound assisted extraction (UAE) and microwave assisted extraction (MAE) techniques.

Wheat flour, sugar, shortening and salt were purchased from local market of Sangrur. Wheat flour was sieved to get rid of bran and other matter. Sugar was ground. Wheat flour and sugar, both were sieved through a 60-mesh screen.

Encapsulation

The encapsulation of the purified extract was done by method used by Kalogeropoulos et al. [21] with certain modifications. Gum Arabica was used as an encapsulating agent.

Cookie Formulation

Cookies were prepared by the formula used by Singh et al. [22] with a slight modification**.**

Cookie ingredients

100 g flour (containing varying proportions of defatted FSP and encapsulated extract), 40 g sugar, 50 g shortening, 1 g sodium chloride, 0.5 g sodium bicarbonate and sufficient water to make required consistency of cookie dough.

Fine ground sugar which has been sieved was firstly creamed with the shortening and rubbed in. Wheat flour containing different proportions of FSP and encapsulated extract was mixed uniformly with sodium chloride and sodium bicarbonate, sieved and mixed with the above mixture. Water was then added to make the dough of desired consistency for cookie preparation. The dough was thinly rolled on a sheeting board to uniform thickness (3.4 mm) and cut using a round cutter to a diameter of 40 mm. The dough pieces were baked in greased pans for 15 min in a baking oven set at temperature of 160°C for above surface and 180°C for lower surface. The baked cookies were cooled for 20 min and stored in air tight container till further analyses.

Physical Analysis of Cookie

Spread ratio

Diameter (D) and thickness (T) of the five cookies from each batch were measured using a vernier caliper. Spread ratio was calculated as ratio of diameter to thickness i.e. D / T. Average values of determinations were reported.

Fracture strength (Snap Test)

The snap test was conducted using a probe 3-point bending attached to texture analyzer. The distance between two beams was 30 mm. While other similar beam was brought down from above at a pre-test speed:2.0 mm / s, test speed:0.5 mm / s, post-test speed:10.0 mm / s, distance:5 mm to

contact the cookie. The downward movement was continued till the cookie broke. The peak force was reported as fracture strength.

Sensory evaluation

The cookies were evaluated by a panel consisting of faculty and students of the Department of Food Engineering & Technology, S.L.I.E.T., Longowal, Sangrur (India). The panelists were naïve to the project. Coded samples of cookies were served on a white disposable plastic tray and distilled water was provided for rinsing the mouth. A nine point hedonic scale with 1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely was used [23]. The members were given written instructions to score on parameters viz. appearance (dull to attractive), color (very dark brown to light brown), initial bite (hard to crisp), taste (bitter to sweet) and mouthfeel (teeth clogging to crunchy). The mean of 10 evaluations was reported.

Statistical Analysis

All the analysis was replicated three times. All the results were analyzed by using commercial statistical package (Trial Version, Inc., Chicago USA) for One-way analysis of variance (ANOVA) with Duncan's test which was used to determine the significant differences between the means at the 5 % level. Differences are considered statistically significant at $p<0.05$.

Results and Discussion

The cookies prepared were supplemented with varying proportions of FSP and the purified and encapsulated fenugreek seed extract. Control sample was prepared from wheat flour only.

Spread ratio of cookies

Data on spread ratio and fracture strength of the cookies as affected by incorporation of defatted FSP and encapsulated extract were presented on Table 1.

Table1: Spread ratio of cookies

Supplementation level (%)	Width, W (cm)	Thickness, T (cm)	Spread ratio (W /T)	Fracture strength (g)
Control (wheat)	5.44 ± 0.19^{a}	1.24 ± 0.25^{b}	4.50 ± 0.12^{b}	3725^{d}
1% FSP	5.04 ± 0.16^{b}	1.28 ± 0.40^{a}	4.35 ± 0.08^{c}	3825^{c}
2% FSP	5.08 ± 0.21^{b}	1.26 ± 0.16^{ab}	4.21 ± 0.16^{d}	3900^{b}
3% FSP	5.12 ± 0.13^{b}	1.29 ± 0.05^{ab}	4.17 ± 0.05^{d}	3925^{b}
4% FSP	5.02 ± 0.08^{b}	1.27 ± 0.05^{a}	4.14 ± 0.06^{d}	4750^{a}
1% encapsulated extract of FSP	5.44 ± 0.09^{a}	1.19 ± 0.04^{b}	5.06 ± 0.21^{a}	3795^{c}
2% encapsulated extract of FSP	5.6 ± 0.2^{a}	1.2 ± 0.14^{b}	5.17 ± 0.16^{a}	3800^{c}

Values are means of ten independent samples. Values not sharing a common superscript in a column are significantly ($p<0.05$) different.

In general, supplementation affected width, thickness and spread ratio. The width of the cookies decreased significantly ($p<0.05$) with the addition of FSP as compared to control, while encapsulated extract of FSP showed non-significant change. The thickness of cookies increased with addition of FSP, while encapsulated extract of FSP didn't show any change. The width and thickness of the control (100 % wheat flour) was 5.44 cm and 1.24 cm respectively. Diameter (width) varied from 5.02 to 5.12 cm and thickness varied from 1.26 to 1.29 cm due to addition of FSP. The changes in the thickness and width were reflected in spread ratio. Spread ratio of the cookies was found to be reduced with increase in level of FSP. The spread factor of the control sample was 4.50 cm. A decrease in the value of spread ratio was observed from 4.35 to 4.14 cm with the increase in level of supplementation of FSP. This could be due to competition of water between FSP and wheat flour for dough consistency. As the composite flours contain more number of hydrophilic sites available, which competes for the limited free water in cookie dough and apparently forms aggregates. As fenugreek contains high amount of fibre, the fibre competes for free water present in the dough leading to increased dough viscosity and thereby limiting cookie spread. Similar results were reported by Hooda and Jood [14] when supplemented FSP in varying proportions with wheat flour for preparation of cookies. Cookies having higher spread ratios are considered most desirable [24]. Similarly other researcher's also observed that height of supplemented biscuit increased, whereas width and spread ratio decreased with the increasing levels of fenugreek flour [25, 26]. A significant ($p<0.05$) increase in the value of spread ratio was observed

with the addition of encapsulated extract of FSP. The spread ratio of the cookies containing the encapsulated extract of FSP was found higher than the control sample. The value of the spread factor observed was 5.06 for 1% encapsulated extract of FSP and 5.17 for 2% encapsulated extract of FSP. This could be due to encapsulation. Gum acacia used for the encapsulation of fenugreek seed extract have the property to retain high water content which helps in high spread ratio during baking.

Effect of supplementation on hardness of the cookies

Inclusion of FSP increased the hardness of the cookies. A significant ($p<0.05$) increase in the value of hardness was observed upon further addition of FSP as indicated in the Table 1. The fracture strength of the control sample was 3725 g. The fracture strength of the cookies increased progressively from 3825 to 4750 g with increase in supplementation level of FSP. On the other hand cookies supplemented with encapsulated extract were found to have lower hardness values than the cookies supplemented with FSP. The lower hardness values of cookies supplemented with encapsulated extract is in correspondence with the higher spread ratio of the cookies. Product containing 4% FSP showed the maximum value for hardness. This could be due to lower spread ratio of the cookies, indicating that lower spread ratio leading to higher hardness. The increase in hardness of the cookies containing FSP can also be contributed to lower fat content of the supplemented flour as the FSP used was defatted.

Sensory evaluation of the cookies

The effects of supplementation of cookies with FSP and encapsulated extract on the sensory characteristics of the cookies are presented in Table 2. A 9-point hedonic scale was used where 9 indicated like extremely and 1 indicated dislike extremely. The data was statistically analyzed by Duncan's test. With change in supplementation level, the sensory factors like color, appearance, taste, mouthfeel and initial bite showed a significant change. Higher level of FSP (i.e. 3% and 4% FSP) showed fewer score than other samples as indicated by sensory panel. The appearance at higher level i.e. 4% FSP showed significant ($p<0.05$) lower score for the product. This may be due to high FSP giving darker image to the product. Replacement of flour with 3% and 4% FSP significantly ($p<0.05$) impaired the taste of the cookies as indicated in Table 2, a significant decrease in the value from 7.29 to 5.86 as FSP was increased. This may be due to the bitter taste of fenugreek seeds and this bitterness was highest for 4% supplementation of FSP. Sensory panel gives the highest score to the cookies supplemented with encapsulated extract of FSP.

The sensory value for mouth feel decreased significantly ($p<0.05$) with increase in level of supplementation. The control sample had 7.57 score which decreased to 5.65 for 4% FSP. This can be due to the bitter taste of FSP and this bitterness increased with increase in the supplementation of FSP. The difference in the scores for initial bite was not considerable acceptable for 4% supplementation level of FSP.

Table 2: Sensory Data for Cookies

Supplementation level (%)	Color	Appearance	Taste	Mouthfeel	Initial bite	Overall acceptability
Control (wheat)	7.07 ± 0.8^{a}	7.06 ± 0.82^{a}	7.43 ± 1.1^{a}	7.57 ± 0.53^{a}	7.21 ± 0.7^{a}	7.07 ± 0.65^{a}
1% FSP	7.21 ± 0.9^{a}	7.06 ± 0.82^{a}	7.29 ± 0.7^{a}	6.86 ± 0.63^{b}	7.29 ± 0.7^{a}	6.38 ± 0.54^{b}
2% FSP	7.29 ± 0.3^{a}	7.14 ± 0.69^{a}	7.29 ± 0.4^{a}	6.86 ± 0.69^{b}	7.14 ± 0.6^{a}	6.19 ± 0.12^{b}
3% FSP	6.86 ± 0.8^{b}	7.17 ± 0.74^{a}	6.71 ± 0.9^{b}	6.43 ± 0.98^{c}	7.00 ± 0.5^{a}	5.67 ± 0.23^{c}
4% FSP	6.36 ± 1.3^{b}	6.56 ± 1.50^{b}	5.86 ± 1.2^{c}	5.86 ± 1.35^{d}	6.71 ± 0.9^{b}	4.28 ± 0.67^{d}
1% encapsulated extract of FSP	7.21 ± 0.7^{a}	7.27 ± 0.74^{a}	7.79 ± 0.7^{a}	7.43 ± 0.79^{a}	7.43 ± 0.4^{a}	7.02 ± 0.76^{a}
2% encapsulated extract of FSP	7.21 ± 0.7^{a}	7.2 ± 0.68^{a}	7.86 ± 0.6^{a}	7.57 ± 0.54^{a}	7.57 ± 0.5^{a}	7.04 ± 0.65^{a}

Values are means of ten samples ± SD. Values not sharing a common superscript in a column are significantly ($p\leq 0.05$) different.

The control sample showed the maximum score for overall acceptability which was 7.07. The values decreased sharply with increase in FSP level. The score values for 1% and 2% FSP were not significantly different. This score decreased from 6.38 for 1% FSP to 4.28 for 4% FSP supplementation. The overall acceptability of the cookies supplemented with 1% and 2% encapsulated extract of FSP has score values similar to control sample. Even 2% of encapsulated extract of FSP had the highest overall acceptability among all the samples considered for the study.

Conclusion

Fenugreek seed extract is possessing lot of physiological health benefits like hypoglycemic effect, hypocholestrolemic effect, possessing antioxidant activity, lactation stimulant, immunomodulator etc. So it can be used as value added food ingradient, which provides advantageous health benefits. Cookies prepared using fenugreek seed extract showed improved physical and sensory properties. These desirable properties of fenugreek seed extract suggested that fenugreek seed extract can be used further in the development of quality cookies. Future research could investigate strategies to improve the quality of cookies containing high levels of FSP as well as fenugreek seed extract.

References

1. Naidu MM, Shyamala BN, Naik PJ, Sulochanamma G, Srinivas P. Chemical composition and antioxidant activity of the husk and endosperm of fenugreek seeds. *LWT - Food Science and Technology*. 2011; 44: 451– 456.
2. Sharma RD, Raghuram TC and Rao NS. Effect of fenugreek seeds on blood glucose and serum lipids in type I diabetes. *European Journal of Clinical Nutrition*. 1990; 44: 301–306.
3. Zia T, Nazrul HS and Hasan SK. Evaluation of the oral hypoglycaemic effect of *Trigonella foenum-graecum L* in normal mice. *Journal of Ethnopharmacology*. 2001; 75: 191–195.
4. Stark A and Madar Z. The effect of an ethanol extract derived from fenugreek (*Trigonella foenum-graecum*) on bile acid absorption and cholesterol levels in rats. *British Journal of Nutrition*. 1993; 69: 277–287.
5. Srinivasan K. Fenugreek (*Trigonella foenum-graecum*): a review of health beneficial physiological effects. *Food Reviews International*. 2006; 22: 203–224.
6. Pandian RS, Anuradha VV and Viswanathan P. Gastroprotective effect of fenugreek seeds (Trigonella foenum-graecum) on experimental gastric ulcer in rats. *Journal of Ethnopharmacology*. 2002; 81: 393–397.
7. Amin A, Alkaabi A, Al-Falasi S and Daoud SA. Chemopreventive activities of *Trigonella foenum-graecum* (Fenugreek) against breast cancer. *Cell Biology International*. 2005; 29: 687–694.
8. Kavirasan S, Naik GH, Gangabhagirathi R, Anuradha CV and Priyadarsini KI. In vitro studies on antiradical and antioxidant activities of fenugreek (*Trigonella foenum-graecum*) seeds. *Food Chemistry*. 2007; 103:31–37.
9. Ahmadiani A, Javan M, Semnanian S, Barat E and Kamalinejad M. Antiinflammatory and antipyretic effects of *Trigonella foenum-graecum* leaves extract in the rat. *Journal of Ethnopharmacology*. 2001; 75: 283–286.
10. Riad S and El-Baradie AA. Fenugreek mucilage and its relation to the reputed laxative action of this seed. *Egyptian Journal of Chemistry*. 1959; 2: 163–168.
11. Petit P, Sauvaire Y, Ponsin G, Manteghetti M, Fave A and Ribes G. Effect of a fenugreek seed extraction on feeding behavior in the rat: metabolic-endocrine correlates. *Pharmacology, Biochemistry and Behavior*.1993; 45: 369–374.
12. Lin LIL, Jian RX, Min MX, Fei WX, Jie Z, Fei W. Protective effects of *Trigonella Foenum graecum L.* on acute cerebral ischemia. *Chinese Pharmacological Bulletin. 2001*; 01.
13. Meghwal M and Goswami TK. A Review on the Functional Properties, Nutritional Content, Medicinal Utilization and Potential Application of Fenugreek. *Journal of Food Processing and Technology*. 2012; 3:9.
14. Hooda, S. Jood, S. Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. *Food Chemistry*. 2005; 90:427– 435.
15. Shirani, G. and Ganesharanee, R. Extruded products with fenugreek (*Trigonella foenum-graecium*) chickpea and rice: physical properties, sensory acceptability and glycaemic index. *Journal of Food Engineering*. 2009; 90: 44 –52.
16. Tsen CC, Peters EM, Schaffer T and WJ Hoover. High protein cookies. I. Effect of soy fortification and surfactants. *Baker's Digest.* 1973; 47: 34: 36 –39.
17. Eneche EH. Biscuit-making potential of millet / pigeon pea flour blends. *Plant Foods for Human Nutrition*.1999; 54:21–27.
18. Singh B, Bajaj M, Kaur A, Sharma S and Sidhu JS. Studies on the development of high-protein biscuits from composite flour. *Plant Foods for Human Nutrition*. 1993; 43:181–189.
19. Singh, B. Cereal-based foods using groundnut and other legumes. In: Uses of Tropical Grain Legumes. pp. 293 – 301. Proceedings of a

Consultants Meeting, March 27–30, 1989. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India; 1991.

20. Hegazy NA and Faheid SMN. Rheological and sensory characteristics of doughs and cookies based on wheat, soybean, chickpea and lupine flour. *Die Nahrung*. 1990; 34:835 – 841.
21. Kalogeropoulos N, Yannakopoulou K, Gioxari A, Chiou A, Makris DP. Polyphenol characterization and encapsulation in â-cyclodextrin of a flavonoid-rich *Hypericum perforatum* (St John's wort) extract. *LWT - Food Science and Technology*. 2010; 43: 882 – 889.
22. Singh GD, Riar CS, Saini C, Bawa AS, Sogi DS, Saxena DC. Indian water chestnut flour- method optimization for preparation, its physicochemical, morphological, pasting properties and its potential in cookies preparation. *LWT - Food Science and Technology*. 2011; 44: 665 – 672.
23. Larmond E. Laboratory methods for sensory evaluation of foods. Canada: Department of Agriculture. 1977; 57:33 –37.
24. Kirssel L and Prentice M. Protein and fibre enrichment of cookie flour with brewer's spent grains. *Cereal Chemistry*. 1979; 50: 261–265.
25. Dhingra S and Jood S. Effect of flour blending on functional, baking and organoleptic characteristics of bread. *International Journal of Food Science and Technology*. 2004; 39:213 –222.
26. Sharma H and Chauhan G. Effect of stabilized rice bran-fenugreek blends on the quality of breads and cookies. *Journal of Food Science and Technology*. 2002; 39: 225 –233.