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Nutritional Evaluation of Cookies Enriched with Bottle Gourd (*Lagenaria Siceraria* l.) Powder

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Abstract-Bottle gourd (*Lagenaria siceraria L.*) is used in traditional Indian medicine and is well known for their antioxidant, anti-stress, analgesic, anti-inflammatory, cardio protective, cardio tonic, diuretic, aphrodisiac, alternative purgative and cooling properties. The study was conducted to improve the nutritional qualities of cookies with addition of different levels of bottle gourd powder. Cookies were prepared with different levels of bottle gourd powder (0, 5, 7, 10, 15 and 20 %) and examined for its physical and chemical composition. The proximate composition of cookies enriched with bottle gourd powder indicated that protein was increased from 9.93 to 13.15 %, crude fibre 0.9-2.75% and spread ratio 3.31-4.20. The incorporation of bottle gourd powder in cookies lowered the lightness (L*) and yellowness (b*) but increased redness (a*) of cookies. The hardness of the cookies was increased with increasing the level of bottle gourd powder. It was concluded that the cookies prepared with addition of 7 to 10% bottle gourd powder were more acceptable as compared to others.
Keywords: Cookies, bottle gourd, protein, crude fiber, color, hardness.

I. INTRODUCTION

Bottle gourd (*Lagenaria siceraria L.*) is an important vegetable crop of tropical and sub-tropical regions of the world belonging to family *Cucurbitaceae*. The fruit finds its medicinal value in traditional Indian medicine and has been used as cardiotonic, aphrodisiac, general tonic, hepatoprotective, analgesic, anti-inflammatory, expectorant and diuretic [1]. Further, antihepatotoxic activity of fruit pulp [2-3]. Phytochemical screening on *L. siceraria* fruit has revealed the presence of fucosterol and compesterols [4], flavonoids, cucurbitacins, saponins, polyphenolics, triterpenoids [5]. Various extracts of fruit of *Lagenaria siceraria* were found to have anti-inflammatory, analgesic, hepatoprotective, anti-hyperlipidemic, diuretic and antibacterial activities [6].

Apart from above the bottle gourd also contents 1.6% choline on a dry weight basis; a precursor to acetylcholine, a chemical used to transfer nerve impulses and hence, it is believed to have neurological effects. Bottle gourd contains cucurbitacins, polyphenols and two sterols namely; campesterol and sitosterol [1]. Bottle gourd is well known for their immunomodulatory, hepatoprotective, antioxidant, anti-stress, adaptogenic, analgesic, anti-

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inflammatory, cardio protective, cardio tonic, antihyperlipidemic, diuretic, aphrodisiac, alternative purgative, antidote to certain poisons and cooling properties [2],[7-8].

The bakery industry is one of the largest organized food industries all over the world and in particular biscuits and cookies are one of the most popular products because of their convenience, ready to eat nature, and long shelf life [9]. Cookies are widely consumed baked products which can be served from breakfast to bedtime. Cookies are appreciated for their taste, aroma, convenience, and long shelf stability due to low moisture content. Recently, increasing consumer demand for healthier foods has triggered the development of cookies made with natural ingredients exhibiting functional properties and providing specific health benefits beyond those to be gained from traditional nutrients [10].

Foods with high nutritional value are in great demand for proper functioning of body systems and potential health benefits. As a result, value-added foods or functional foods with higher level of dietary fiber and antioxidant have been developed, especially in bakery products such as cookies. The incorporation of composite flour into traditional wheat based food products provided additional nutrients from non-wheat material and improved the nutritional value of the products [11].

The utilization of bottle gourd powder with wheat flour in bakery products have not been studied extensively. Therefore, the research was designed to evaluate the effect of substitution of wheat flour with different levels of bottle gourd powder on the physico-chemical and sensory properties of the cookies.

II. MATERIALS AND METHODS

1. Materials

Fresh green and well matured bottle gourds were obtained from the local market of Rahuri, Dist. Ahmednagar. The ingredients for cookies such as wheat flour, fat, sugar, ammonium bi-carbonate and sodium bi carbonate were used from, pilot bakery unit of the department of food science and technology, MPKV Rahuri.

2. Processing of bottle gourd powder

Fresh bottle gourds were washed, peeled and reduced to size (1-3 mm) using sharp knife. The slices were blanched and dried in tray dryer at 60-65 ^{O}C for about 7-8 h. The dried bottle gourd slices were subjected to grinding in grinder. Then ground material was passed through 60 mesh sieve and packed in HDPE bags, sealed and stored for further use.

3. Cookies preparation

Bottle gourd cookies were prepared by substituting refined wheat flour with bottle gourd powder (BGP). Various blends were prepared using refined wheat flour and bottle gourd powder in the ratio of 100:0; 95:5; 93:7; 90:10; 85:15; 80:20. The cookies were prepared using procedure as suggested in Fig. 1.

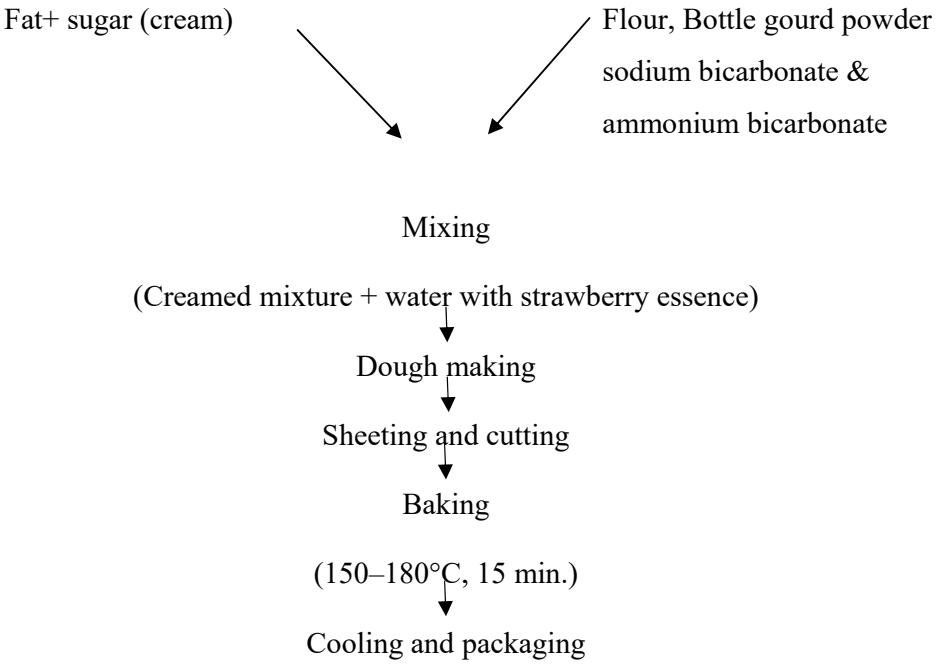

Fig.1. Method for preparation of cookies

4. Physical characteristics

The physical characteristics of cookies such as diameter, thickness, spread ratio were measured as described in the A.A.C.C. (2000) methods [12].

5. Sensory evaluation of cookies:

The cookies were evaluated by panel of 10 semi-trained judges. Nine-point Hedonic Scale and Score Card method were used for evaluation of sensory characteristics of different cookies [13].

6. Texture measurement

Texture of cookies was evaluated by a universal texture analyser (AG X, Shimadzu Japan, capacity 2500N [14].

7. Colour measurement

Surface color of cookies was determined by measuring tristimulus L (brightness), a (redness), b (yellowness) and Hue (H) values with a colorimeter (CIELAB) [15].

8. Proximate composition

Proximate analysis of cookies for moisture, crude protein, crude fat and ash content were determined according to the AOAC (2000) standard methods [16]. The carbohydrate content was determined by subtracting the sum of the values (per 100 g) for moisture, total ash, crude fat, crude fibre and crude protein from hundred. The calorific value (Kcal per 100g) of sample was calculated by summing up the product of multiplication of per cent crude protein, crude fat and carbohydrate present in the sample by 4, 9, and 4, respectively [17].

9. Statistical analysis: All results were statistically analysed by using CRD [18].

III. RESULTS AND DISCUSSION

1. Proximate composition

Moisture content of control was 2.57% and that of cookies containing bottle gourd powder increased from 2.97 to 5.10 %. Crude protein content of control was 10.19 % and that of cookies containing incremental levels of bottle gourd powder increased from 9.93 to 13.15 % (Table 1). Ash content of the cookies containing incremental levels of bottle gourd powder was increased from 1.44 to 2.16 % which was significantly higher than that of control. Crude fiber content of cookies was significantly increased from 0.95 to 2.75 % with addition of bottle gourd powder up to 20%. Crude fat and carbohydrates contents were decreased from 23.42 to 22.22 %, 62.98 to 57.37 respectively with addition of bottle gourd powder. The difference in moisture content between samples might be due to the high fiber content in bottle gourd. More hydroxyl groups of cellulose in fiber were able to bind with free water molecules through hydrogen bonding and thus resulting in greater water holding capacity [19]. Results showed that higher amount of bottle gourd powder substituted into formulation resulted in increased protein and fiber content in cookies in accordance with the findings of [20-21].

It is revealed that with increased level of bottle gourd powder in cookies, there was increase in calcium, phosphorous, iron and zinc content of cookies with decrease in calorific value of cookies. The calcium content of cookies increased from 30.12 to 38.47, phosphorous content increased from 151 to 162, iron content was increased from 1.13 to 3.24 and zinc content from 0.31 to 0.77 with increased level of bottle gourd powder in cookies. Results showed that higher amount of bottle gourd powder substituted into formulation resulted in increased minerals content in cookies in accordance with the findings of [20] and [10].

Table 1: Chemical composition of bottle gourd powder incorporated cookies

Treatments*	Moisture (%)	Protein (%)	Fat (%)	Carbohydrates (%)	Ash (%)	Crude fiber (%)
T_0	2.57	10.19	23.42	62.98	0.84	0.95
T_1	2.97	9.93	23.14	62.52	1.44	0.99
T_2	3.41	10.76	22.78	61.44	1.61	2.25
T_3	3.90	11.07	22.44	60.97	1.62	2.49
T_4	4.48	12.36	22.27	59.09	1.80	2.43
T_5	5.10	13.15	22.22	57.37	2.16	2.75
SE ±	0.14	0.16	0.05	0.03	0.03	0.04
CD @5%	0.43	0.48	0.13	0.08	0.10	0.13

* Indicates proportion of wheat flour: bottle gourd powder

T_0 (100:0), T_1 (95:5), T_2 (93:7), T_3 (90:10), T_4 (85:15) and T_5 (80:20).

Table 2. Effects of bottle gourd powder on micro-nutrient of cookies

Treatments*	Calcium mg/100g	Phosphorous mg/100g	Iron mg/100g	Zinc mg/100g	Calorific value (kcal)
T_0	30.12	151	1.13	0.77	510.77
T_1	32.21	153	1.81	0.31	505.30
T_2	33.06	155	2.62	0.35	501.04
T_3	35.31	157	2.04	0.38	497.32
T_4	36.74	160	3.15	0.42	493.37
T_5	38.47	162	3.24	0.51	489.11
SE ±	0.715	1.354	0.063	0.008	0.204
CD @ 5%	2.124	4.024	0.187	0.023	0.606

* as suggested in Table 1.

2. Texture analysis of cookies

It was revealed that the hardness of cookies was found to increase with addition of bottle gourd powder (Table 3). The increased hardness may be attributed to dilution of wheat proteins with bottle gourd proteins and fiber. There was positive correlation of fiber and protein contents with the hardness value of cookies made [22]. The increase in cookies hardness was observed with increased fiber substitution [23]. The dough prepared from high-absorption flour resulted in hard texture [24]. Therefore, high fiber content in bottle gourd powder was evident to produce cookies with hard texture.

Table 3: Effect of different levels of bottle gourd powder on textural characteristics of cookies

Treatments*	Force Max (N)	Break Force Sensitivity (N)	Max Displacement Force (N)	Energy (J)
T_0	57.88	55.44	20.49	0.05
T_1	50.62	50.65	8.32	0.04
T_2	55.64	55.55	11.52	0.06
T_3	63.64	63.43	15.48	0.07
T_4	69.64	69.33	20.58	0.07

T_5	79.29	79.41	39.38	0.09
SE ±	0.12	0.11	0.11	0.00
CD @5%	0.35	0.32	0.34	0.01

* as suggested in Table 1.

3. Physical characteristics of cookies

There were no significant differences in the diameter and thickness of the cookies between those containing up to 5.0% bottle gourd powder and the control (Table 4). However, significant differences were found with higher levels of bottle gourd powder. Larger diameter and lower thickness values were observed as the level of bottle gourd powder substitution increased. The incorporation of bottle gourd powder affected cookie expansion by lowering gas retention compared to control. The spread ratio of cookies made with bottle gourd powder was significantly lower than that of control. [25] reported that cookies made with yam powder exhibited a reduction in size and thickness as the content of yam powder increased. It was reported that the spread ratio of cookies prepared with bamboo leaf powder decreased with increased amount of bamboo leaves powder [26]. [27] also reported that the addition of sea tangle powder lowered the spread ratio of cookies. The cookies spread ratio or diameter is used as an indicator of cookie quality and cookies with larger spread or diameter were considered more desirable [28].

Table 4: Physical parameters of bottle gourd powder incorporated cookies

Treatments*	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ratio
T_0	9.48	43.26	10.29	4.20
T_1	9.45	43.15	12.51	3.99
T_2	10.04	44.25	10.82	3.54
T_3	10.28	44.65	12.45	3.59
T_4	10.59	45.05	13.03	3.46
T_5	10.82	46.58	14.09	3.31
SE ±	0.18	0.22	0.38	0.08
CD @5%	0.53	0.65	1.13	0.24

* as suggested in Table 1.

4. Colour measurement

The data presented in Table 5 illustrated that control cookies had significant difference in terms of L (Lightness), a (Redness), b (yellowness), C (chroma) and h (hue) values compared to all other cookies made by substitution with bottle gourd powder. The lightness value of control cookies was 68.78 and those of bottle gourd powder cookies decreased from 59.90 to 50.88, indicating that lightness decreased with the reduction in the proportion of wheat flour

because of the loss of white color of the flour. The redness value of control cookies was 4.677 and those of bottle gourd powder cookies was ranged 6.186～6.651, showing more reddish color than control. The yellowness value of control cookies was 22.853 and cookies substituted with different levels of bottle gourd powder decreased from 19.832 to 15.2974, having more yellowish color than control. Hue refers to a term that describes the pure spectrum color without tint or shade. The increased level of substitution of bottle gourd powder significantly reduced the hue value.

[20,29] observed decreased lightness of cookies as the substitution level of fiber into formulation was elevated. Control cookies had significant difference in b* and C* values compared to other cookies. The differences in color could be due to uneven exposure of cookies' surface area to high baking temperature and colored compounds formed from chemical reactions such as caramelization and Maillard reaction [30]. Borrelli *et al.* (2003) reported that the reaction between protein and carbohydrate was responsible for the brown colour and organoleptic properties of bakery products [31].

Table 5: Effect of different levels of bottle gourd powder on color characteristics of cookies

Treatments*	L*	a*	b*	C*	H*
T_0	68.783	4.677	22.853	23.255	78.334
T_1	59.905	6.404	19.832	20.923	78.083
T_2	58.677	6.454	19.187	20.182	75.298
T_3	57.262	6.675	19.131	20.103	70.814
T_4	52.731	6.186	15.695	16.839	68.846
T_5	50.876	6.651	15.297	16.484	66.686
SE ±	0.499	0.075	0.023	0.049	0.056
CD @5%	1.481	0.222	0.067	0.146	0.168

* as suggested in Table 1.

5. Sensory evaluation:

The treatment T_2 obtained higher average score for color and appearance (7.54) with minimum score by treatment T_5 (5.60). The treatment T_2 obtained highest score for texture and grain (7.76), flavor (8.13), taste (7.98) and overall acceptability (7.83) as compared to control T_0 treatment (Table 6). The surface colour was darker as the bottle gourd powder level increased. Therefore, replacing up to 7-10% wheat flour with bottle gourd powder would not result in significant differences in the acceptability of cookies.

Table 6: Effect of different levels of bottle gourd powder on sensory characteristics of cookies

Treatments*	Colour and	Texture	Flavour	Taste	Overall

	appearance				**acceptability**
T_0	8.19	7.74	7.67	7.83	7.80
T_1	7.51	7.62	7.73	7.66	7.67
T_2	**7.54**	**7.76**	**8.13**	**7.88**	**7.82**
T_3	6.65	6.65	6.84	6.57	6.67
T_4	6.31	6.21	6.51	6.24	6.14
T_5	5.60	5.50	6.09	5.69	5.67
SE ±	0.120	0.098	0.087	0.072	0.059
CD @5%	0.358	0.293	0.259	0.213	0.174

* as suggested in Table 1.

IV. CONCLUSION

Nutritional analysis revealed that the increased substitution level of bottle gourd powder up to 7-10 % increased the nutritional content (crude protein, crude fiber and minerals) when compared to control cookies. Bottle gourd powder also provided greater overall acceptability but increased the hardness value of cookies. For the colour properties, the substitution of bottle gourd powder reduced the L* and H (hue) value but increased the a* value. Overall, it can be concluded that the substitution of wheat flour with bottle gourd powder up to 7-10% into the formulation of cookies enhanced the nutritional value of cookies.

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