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Effect of incorporation of cauliflower leaf powder on sensory and nutritional composition of malted wheat biscuits

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Cauliflower leaves are rich in β-carotene and iron and has highest waste index. Therefore, an attempt was made to utilize its leaves in value added product, thus reducing the wastage. The malted wheat flour was blended with cauliflower leaf powder in the ratios of 10, 20 and 30% for the development of biscuits. The developed products were stored for 90 days to ascertain the changes in proximate composition and sensory characteristics. The highest moisture, crude protein, crude fibre and ash content of 1.68, 9.49, 13.32 and 1.49% were recorded in biscuits prepared from 70:30: malted wheat flour: cauliflower leaf powder, respectively. However, 100:00: whole wheat flour: cauliflower leaf powder recorded highest value of crude fat (21.96%). On the basis of sensory evaluation, biscuits prepared from 90:10: malted wheat flour: cauliflower leaf powder was adjudged the best with regard to their acceptability and storability.

Key words: Cauliflower leaves, biscuits, malted wheat, β-carotene, iron, protein, fibre.

INTRODUCTION

The food processing industry produces large quantities of waste products. Over one million tonnes of vegetable trimmings from the vegetable processing industry are produced every year which can be used for value addition. They are inexpensively available in large quantities characterized by a high dietary fibre content resulting with high water binding capacity and relatively low enzyme digestible organic matter (Serena and Bach-Knudsen, 2007). However, studies on the use of vegetable fibre are scanty. Among vegetables, cauliflower (*Brassica oleraceae* var. *Botrytis*) is the most popular cole vegetable grown extensively in India. It belongs to family Brassicaceae. It is rich in nutrients but has highest waste index. The edible portion of cauliflower is curd (head), whereas, its leaves which are generally thrown away as waste are also rich source of iron and β-carotene and thus can be utilized in various value added products (Kowsalya and Sangeetha, 1999). The leaves contribute about 50% of the total production of cauliflower. The leaves of cauliflower are available only for a short period but these can be dried or stored for use during lean season (Singh et al., 2005). Dehydrated leaves are also rich source of β-carotene and iron which can be used in sparce season (Rao, 1993). Pilot studies have indicated that this effort is feasible and these dried vegetables are of good nutritive value and are acceptable (Gopalan, 1996). Wheat (*Triticum* spp.) on the other hand, is a worldwide cultivated cereal from the Fertile Crescent of the East. Wheat grain is a staple food and forms the major source of proteins and calories for large

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section of Indian population. Malting is a process of germination and subsequent drying of a grain. As a result, the complex proteins are degraded to readily available lower molecular weight fractions. Increases in protein and starch digestibility have been reported in germinated grains. These grains have been used in the formulation of low viscosity weaning supplementary and breakfast foods. Very few studies indicate the use of malted grains in snacks and biscuits (Goyle and Gujral, 1998).

Keeping in view the aforementioned facts, the present investigation were undertaken to examine the effect of blending cauliflower leaf powder and malted wheat on proximate composition of biscuits during storage.

MATERIALS AND METHODS

Cauliflower leaf powder

Cauliflower (*Brassica oleracea*) leaves were obtained in a single lot from local market. The leaves were separated from their stalks, washed under running tap water and were blanched for 10 to 15 s. After blanching the leaves were dried at room temperature for 1 to 2 h by spreading on filter paper followed by drying in hot air oven at 40°C for 4 to 6 h. The dried leaves were ground to fine powder, passed through 20 mesh seive and packed in air tight containers for further use.

Wheat

Wheat was procured in a single lot from the Division of Plant Breeding and Genetics, SKUAST-Jammu. The cleaned and dried wheat were divided into 3 lots. One lot was milled into flour and was treated as whole wheat flour.

Malted wheat flour

Malted wheat flour was prepared by soaking wheat for 12 h in water twice their volume. After that, the water was drained off, the soaked grains were wrapped in a moist muslin cloth and kept for germination for a period of 48 h at room temperature. The germinated wheat having an average root length of 1.6 to 3.3 cm, respectively were oven dried at 70 ± 5°C and milled (Table 1) (Goyle and Gujral, 1998).

Preparation of biscuits (sweet 'n' salty)

The process for preparation of sweet 'n' salty biscuits using flour of wheat was standardized using creaming method (Figure 1) (Singh et al., 2005).

Storage

The treatment combinations of wheat-cauliflower leaf powder products (in triplicate) namely, biscuits were packed in polythene pouches (Gauge 300) and then stored for a period of 90 days at room temperature. The stored products were analyzed for physico-chemical changes and sensory characteristics at an interval of 30 days.

Proximate analysis of wheat-cauliflower leaf powder biscuits

Moisture, ash and crude fibre were determined according to AOAC (1995). Crude protein was estimated by using micro-kjeldahl method, AOAC (1995) using the factor 6.25 for converting nitrogen content into crude protein. For fat content of noodles, 5 g sample was placed in Soxhlet extraction apparatus and subjected to extraction for 6 h using petroleum ether as solvent and percent fat content of noodle samples were calculated on a weight basis. β-carotene was determined by soaking 5 g sample in 15 ml of AR grade acetone for 2 h at room temperature under dark condition in order to get complete carotene extraction. The carotene layer was separated using petroleum ether through separating funnel. The volume was made up to 100 ml with petroleum ether and then this layer was again passed through sodium sulphate over the funnel in order to remove moisture from the layer. The optical density of the layer was measured at 452 nm using petroleum ether as blank (Srivastava and Kumar, 2002). Iron was determined by dissolving ash sample in 0.1 N (3 ml) hydrochloric acid in a crucible. It was then kept on water bath at 100°C and evaporated to dryness. 0.1 N (4 ml) hydrochloric acid and 2 ml distilled water were added and the dissolved fraction was filtered, made to 50 ml with distilled water and compared with iron standard curve at 535 nm OD (Thimmaiah, 1999).

The samples were evaluated for overall acceptability by semi-trained panel of 7 to 8 judges by using 9 point hedonic scale assigning scores 9- like extremely to 1- dislike extremely. A score of 5.5 and above was considered acceptable (Amerine et al., 1965).

Statistical analysis

The data obtained (in triplicate) were evaluated statistically with OPSTAT package program (OPSTAT software for Windows) by variance analysis. When variance analysis showed significant difference ($p<0.05$) among the means, the least difference test was used to evaluate means.

RESULTS AND DISCUSSION

Moisture

Biscuits prepared by using different ratios of wheat and cauliflower leaf powder revealed that there was significant increase in mean moisture content from 1.63 to 1.68% during 90 days of storage period (Table 2). The highest moisture content of 1.68% was recorded in T_8 (70:30:: malted wheat flour: cauliflower leaf powder) and the lowest of 1.63% in T_4 (70:30:: roasted wheat flour: cauliflower leaves powder). The increase in moisture content of biscuits might be due to hygroscopic nature of cauliflower leaf powder and wheat flour. Similar results were reported by Kumar and Barmanray (2007) in button mushroom fortified biscuits.

Crude protein

At 0 day storage, treatment T_8 (70: 30: malted wheat flour: cauliflower leaves powder) recorded highest protein content of 9.51% followed by T_7 (80:20: malted wheat flour: cauliflower leaves powder), having value 9.44% and T_6 (90:10: malted wheat flour: cauliflower leaves powder)

Table 1. Composition of different treatments used for the study.

Treatment	Details
T_1	100:00:: Whole Wheat flour: Cauliflower leaves
T_2	90:10:: Whole Wheat flour: Cauliflower leaves
T_3	80:20:: Whole Wheat flour: Cauliflower leaves
T_4	70:30:: Whole Wheat flour: Cauliflower leaves
T_5	100:00:: Malted Wheat flour: Cauliflower leaves
T_6	90:10:: Malted Wheat flour: Cauliflower leaves
T_7	80:20:: Malted Wheat flour: Cauliflower leaves
T_8	70:30:: Malted Wheat flour: Cauliflower leaves

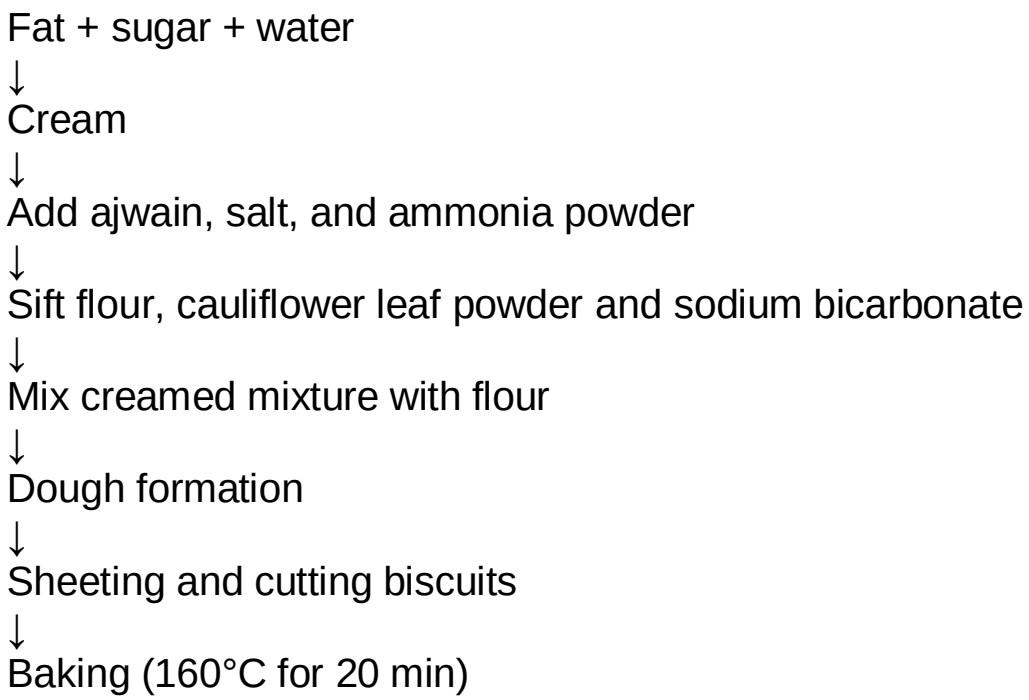

Figure 1. Flow chart of preparation of sweet 'n' salty biscuits.

having value 9.43% (Table 3). However, after 90 days of storage treatment, T_2 (90:10: whole wheat flour: cauliflower leaves powder) recorded the lowest value of 7.29% and highest value of 9.46% was observed in T_8 (70:30: malted wheat flour: cauliflower leaves powder). It was observed that with the passage of time during storage, crude protein content decreased significantly in all treatments. It decreased from its mean value of 8.41 to 8.36% during storage of 90 days. The decrease in protein content during storage might be due to hydrolysis of peptide bonds by the help of protease enzyme that cause splitting of protein molecules during storage. Similar decrease of protein content with storage period was reported by Kanchana et al. (2008) in value added single cell protein biscuits and Nwabueze and Atuonwu (2007) in African bread fruit seeds incorporated biscuits.

Crude fat

Data in Table 4 shows that the crude fat content of biscuits was influenced significantly by different treatments. The highest crude fat content (22.62%) was recorded in treatment T_1 (100:00: whole wheat flour: cauliflower leaves powder) at 0 day storage followed by 22.29% in T_2 (90:10: whole wheat flour: cauliflower leaves powder). The treatment T_8 (70:30: malted wheat flour: cauliflower leaves powder) recorded the lowest value of 19.35% at 90 days storage followed by T_5 (100:00: malted wheat flour: cauliflower leaves powder) having value of 19.90%. The reduction of fat content in malted samples might be due to sprouting which increases the activity of lipase enzyme leading to decreased fat content. These findings are in accordance

Table 2. Effect of treatments and storage period on moisture (percent) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	1.64	1.65	1.66	1.68	1.66
T_2	1.62	1.63	1.65	1.66	1.64
T_3	1.61	1.64	1.66	1.68	1.65
T_4	1.60	1.62	1.64	1.66	1.63
T_5	1.62	1.64	1.65	1.66	1.64
T_6	1.64	1.66	1.68	1.69	1.67
T_7	1.64	1.65	1.67	1.68	1.66
T_8	1.66	1.67	1.68	1.70	1.68
Mean	1.63	1.65	1.66	1.68	

Effects of C.D. ($p = 0.05$), Treatment, 0.01; Storage, 0.01; Treatment × storage, NS.

Table 3. Effect of treatments and storage period on crude protein (percent) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	7.36	7.34	7.34	7.33	7.34
T_2	7.37	7.36	7.35	7.29	7.34
T_3	7.38	7.36	7.34	7.32	7.35
T_4	7.38	7.38	7.36	7.35	7.37
T_5	9.42	9.41	9.40	9.37	9.40
T_6	9.43	9.43	9.41	9.38	9.41
T_7	9.44	9.43	9.42	9.39	9.42
T_8	9.51	9.5	9.48	9.46	9.49
Mean	8.41	8.40	8.39	8.36	

Effects C.D. ($P = 0.05$); Treatment, 0.01; Storage, 0.02; Treatment × storage, NS.

Table 4. Effect of treatments and storage period on crude fat (percent) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	22.62	22.07	21.97	21.18	21.96
T_2	22.29	21.96	21.57	20.88	21.67
T_3	22.24	22.07	21.51	20.63	21.61
T_4	21.97	21.71	21.07	20.14	21.22
T_5	20.98	20.67	20.15	19.90	20.43
T_6	20.83	20.49	20.21	20.07	20.40
T_7	20.64	20.06	19.78	19.44	19.98
T_8	20.12	19.75	19.56	19.35	19.70
Mean	21.46	21.09	20.73	20.20	

Effects C.D. ($P = 0.05$); Treatment, 0.02; Storage, 0.09; Treatment × storage, 0.18.

with the findings of Singh et al. (2008) which reported that crude fat decreased with storage in biscuits supplemented with various levels of jaggery.

Crude fibre

The data pertaining to crude fibre content of different

Table 5. Effect of treatments and storage period on crude fiber (percent) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	6.12	6.05	5.89	5.65	5.93
T_2	6.82	6.73	6.62	6.43	6.65
T_3	7.57	7.38	7.34	7.10	7.35
T_4	8.39	8.32	8.14	7.84	8.17
T_5	10.72	10.60	10.40	10.30	10.50
T_6	11.50	11.34	11.26	11.17	11.32
T_7	12.53	12.36	12.24	12.19	12.33
T_8	13.62	13.35	13.23	13.07	13.32
Mean	9.66	9.52	9.39	9.22	

Effects C.D. (P = 0.05);treatment, 0.02; Storage 0.03; treatment × storage, 0.07.

Table 6. Effect of treatments and storage period on ash (percent) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	1.10	1.07	1.04	1.03	1.06
T_2	1.13	1.11	1.08	1.04	1.09
T_3	1.14	1.11	1.09	1.06	1.10
T_4	1.20	1.18	1.12	1.10	1.15
T_5	1.33	1.27	1.21	1.16	1.24
T_6	1.46	1.39	1.31	1.25	1.35
T_7	1.43	1.38	1.32	1.26	1.35
T_8	1.59	1.49	1.46	1.42	1.49
Mean	1.30	1.25	1.20	1.17	

Effects C.D. (P = 0.05); treatment, 0.02; Storage, 0.01; treatment × storage, NS.

treatments in Table 5 depicts a significant decrease in crude fibre content for storage duration is concerned. However, with the incorporation of cauliflower leaf powder, the fibre content increased. The mean value of crude fibre content decreased from the initial level of 9.62 to 9.22% after 90 days of storage. At the beginning, the highest crude fibre content of 13.62% was recorded in T_8 (70:30: malted wheat flour: cauliflower leaves powder); whereas, the lowest crude fibre content of 6.12% was recorded in T_1 (100:00: whole wheat flour: cauliflower leaves powder). After 90 days of storage, the maximum crude fibre of 13.07% were recorded in T_8 (70:30: malted wheat flour: cauliflower leaf powder); whereas, the minimum crude fibre of 5.65% were recorded in T_1 (100:00: whole wheat flour: cauliflower leaf powder). The decrease in crude fibre might be due to the degradation of hemicelluloses and other structural polysaccharides during storage. Also, heat and moisture solubilizers degrade pectic substances leading to the decrease in the fibre content (Sharon and Usha, 2006). Similar decline in crude fibre content was reported by Singh et al. (2006) in pearl millet cake.

Ash

A perusal of data in Table 6 revealed that the effect of treatments on ash content (percent) of biscuits was significant. The treatment T_8 (70:30:: malted wheat flour: cauliflower leaf powder) recorded the highest value of 1.59% at 0 day storage; whereas, treatment T_1 (100:00: whole wheat flour: cauliflower leaf powder) recorded lowest ash content value of 1.03% after 90 days of storage followed by 1.04% in T_2 (90:10: whole wheat flour: cauliflower leaves powder) and 1.06% in T_3 (80:20: whole wheat flour: cauliflower leaves powder). The highest mean ash content of 1.49% was recorded in case of treatment T_8 (70:30: malted wheat flour: cauliflower leaves powder) which might be due to soaking of grains in tap water during sprouting. Since the water is good source of minerals, as a result through osmosis, ash content of malted grains increased. These results were supported by the findings of Eyidemir and Hayta (2009) in

Table 7. Effect of treatments and storage period on iron (mg/100 g) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	5.10	5.07	5.04	5.03	5.06
T_2	5.13	5.11	5.08	5.04	5.09
T_3	5.14	5.11	5.09	5.06	5.10
T_4	5.20	5.18	5.12	5.10	5.15
T_5	5.33	5.27	5.21	5.16	5.24
T_6	5.43	5.39	5.31	5.25	5.35
T_7	5.46	5.38	5.32	5.26	5.35
T_8	5.59	5.49	5.46	5.42	5.49
Mean	5.30	5.25	5.20	5.17	

Effects C.D. (P = 0.05); treatment, 0.03; storage, 0.03; treatment × storage, 0.04.

Table 8. Effect of treatments and storage period on β-carotene (mg/100 g) of wheat - cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	2.76	2.64	2.27	1.96	2.41
T_2	2.78	2.74	2.32	1.97	2.45
T_3	2.80	2.74	2.35	2.00	2.47
T_4	2.86	2.76	2.38	2.03	2.51
T_5	2.91	2.83	2.48	2.13	2.59
T_6	2.99	2.92	2.49	2.13	2.63
T_7	3.07	3.01	2.58	2.18	2.71
T_8	3.13	3.05	2.72	2.32	2.81
Mean	2.92	2.84	2.45	2.09	

Effects C.D. (P = 0.05); treatment, 0.02; storage, 0.05; treatment × storage, 0.08.

noodles supplemented with apricot kernel flour.

Iron

The effect of various treatments and storage on iron content of biscuits is represented in Table 7. The data revealed that the iron content of biscuits was significantly influenced by different treatments and increased with the increase in the percentage of incorporation of cauliflower leaf powder. Among various treatments, T_8 (70:30:: malted wheat flour: cauliflower leaves powder) recorded the highest iron content of 5.59 (mg/100 g) followed by T_7 (80:20:: malted wheat flour: cauliflower leaves (powder form) having an iron content of 5.46 (mg/100 g) at 0 day storage. However, after 90 days storage, lowest iron content of 5.03 (mg/100 g) was recorded by treatment T_1 (100:00: whole wheat flour: cauliflower leaves powder) followed by T_2 (90:10: whole wheat flour: cauliflower leaves powder) with iron content of 5.04 (mg/100 g). The highest mean iron content of 5.49 (mg/100 g) was recorded by treatment T_8 (70:30: malted wheat flour: cauliflower leaves powder) and the lowest mean iron content of 5.06 (mg/100 g) was recorded by treatment T_1 (100:00: whole wheat flour: cauliflower leaves powder). Similar results have been reported by Sikandra and Boora (2009).

β-Carotene

A glance of data in Table 8 reveals that with the incorporation of cauliflower leaves, the β-carotene content increased. At the beginning, treatment T_8 (70:30: malted wheat flour: cauliflower leaves powder) recorded highest β-carotene content of 3.13 (mg/100 g) followed by T_7 (80:20: malted wheat flour: cauliflower leaf powder) with β-carotene content of 3.07 (mg/100 g). On the other hand, after 90 days of storage, treatment T_1 (100:00: whole wheat flour: cauliflower leaf powder) recorded the

Table 9. Effect of treatments and storage period on mean score evaluation of overall acceptability of wheat-cauliflower leaf powder blended biscuits.

Treatment	Storage period (days)				
	0	30	60	90	Mean
T_1	7.73	7.7	7.65	7.59	7.67
T_2	7.79	7.55	7.34	7.21	7.47
T_3	6.10	5.97	5.85	5.66	5.90
T_4	5.58	5.38	5.16	5.04	5.29
T_5	7.49	7.28	7.22	7.38	7.34
T_6	8.20	8.02	7.91	7.67	7.95
T_7	6.57	6.41	6.27	6.15	6.35
T_8	6.32	6.18	6.04	5.94	6.12
Mean	6.97	6.81	6.68	6.58	

Effects C.D. (P = 0.05): treatment, 0.02; storage, 0.03; treatment × storage, 0.09.

lowest value of 1.96 (mg/100 g) followed by T_2 (90:10: whole wheat flour: cauliflower leaf powder) having β-carotene content of 1.97 (mg/100 g). Highest mean β-carotene content of 2.81 (mg/100 g) was recorded in treatment T_8 (70:30:: malted wheat flour: cauliflower leaves powder); whereas, the lowest β-carotene content of 2.41 (mg/100 g) was recorded by treatment T_1 (100:00:: whole wheat flour: cauliflower leaf powder).

The decrease in β-carotene content during storage might be due to the oxidative degradation of colour pigment. Potter (1987) also reported that carotenoids are very sensitive to oxidation which results in loss of colour. However, with the increasing level of incorporation of cauliflower leaf powder, the β-carotene content increased which might be due to higher concentration of β-carotene in leaves. The findings of Bhavani and Kamini (1997) in extruded maize products also support the same results.

Overall acceptability

Table 9 pertaining to the mean score awarded to the quality attributes of overall acceptability of biscuits reveals that at the beginning of storage, the maximum score of 8.20 was recorded in T_6 (90:10: malted wheat flour: cauliflower leaves powder); whereas, the minimum score of 5.58 was recorded in T_4 (70:30: whole wheat flour: cauliflower leaves powder). As the storage period advanced, there was decrease in overall acceptability score. After 90 days of storage, the highest score of 7.67 was recorded in T_6 (90:10:: malted wheat flour: cauliflower leaves powder). The mean score for overall acceptability attribute decreased from 6.97 to 6.58 during 90 days of storage. Similar results have been reported by Stojceska et al. (2008) in cereal based ready to eat expanded snacks using cauliflower by products.

Conclusion

Therefore, it can be concluded that incorporation of cauliflower leaf powder in biscuits up to 10% along with malted wheat flour not only improves the texture, taste and overall acceptability but also improves the nutritive value of these products without adding much to the cost of the product and cauliflower leaves, which are generally thrown away can be utilized in a better way, thus reducing wastage.

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