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Fortification of carrot, jackfruit and aonla powder to enhance nutritional and sensory qualities of sweet biscuits

Abstract

We investigated the effect of partial replacement of wheat flour by different levels of carrot powder (10 and 20%) jackfruit powder (25 and 50%) and aonla powder (10, and 20%) on the color, nutritional and sensory characteristics of the sweet biscuits. at the Department of Post Harvest Technology Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India. Results of chemical analysis indicated that, the crude fiber content increased to 0.95 per cent in 80% refined wheat flour+ 50% carrot powder significantly ($p<0.05$) versus 0.35 (100% wheat flour) in control treatment. Incorporation of carrot, jackfruit and aonla powders in sweet biscuits contributed to the increase in crude fiber content. However, during the storage period of three months, there was decrease in reducing, non-reducing and total sugar from 9.82 to 9.25%, 1.72 to 1.51% and 11.54 to 10.76% and moisture content and water activity increased from 4.88 to 5.62% and 0.35 to 0.47% respectively. A result revealed that biscuits processed from refined wheat flour supplemented by 25% of jackfruit powder had higher acceptance scores for sensory characteristics during initial (4.58 out of 5) and throughout the storage period (4.16 out of 5) than the other blends.

Keywords: biscuit, refined wheat flour, carrot powder, jackfruit powder, aonla powder, sensory properties and nutritional properties

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Introduction

Biscuits are popular due to their longer shelf life, easy marketability, low cost, varied taste and texture. Being low in moisture, biscuits can be stored for longer period at room temperature. They are increasingly becoming popular ready-to-eat (RTE) products in Indian households. It is estimated that 2.0 to 2.5lakh tonnes of biscuits are manufactured annually by the organized sector and another 4.0 to 4.5 lakh tonnes by the unorganized sector in the country.[1] Biscuit market in recent years has witnessed a growth rate of 8 to 10% annum and particularly, cream and speciality biscuits are growing at a faster pace of 20% per annum.[2] With increase in popularity, it is essential to enhance the functionality of the product to provide healthy options.

Fruits and vegetables are good sources of fibers, minerals and vitamins. They are cheaper and easily available, but are seasonal and highly perishable. Nearly 40per cent of fruits and vegetables go waste due to their perishable nature, lack of appropriate post-harvest infrastructure and transportation, inadequate marketing set up and processing.[3] Processing of fruits and vegetables reduce the post-harvest losses and make them available throughout the year.[4] In this context, utilization of substantial quantum of fruits and vegetables in bakery products such as, bread and biscuits not only improves the functionality of these foods but also helps in reducing the post-harvest losses of fruits and vegetables. Therefore, the present study was undertaken to develop sweet biscuits with the following objectives:

i. To optimize the level of incorporation of selected fruits and vegetables in biscuits

ii. To study the nutritional and sensory quality of developed functional foods

Materials and methods

Carrots (*Daucus carota*) procured from Gokak vegetable market was washed with tap water in the laboratory to remove adhered soil particles. Carrots were then grated and subjected for blanching in boiling water for 60seconds. Blanched carrot grates were dried in a tray drier at 60°C temperature for 6hours. The dried carrot grates were ground to fine powder. Jackfruit (*Artocarpus heterophyllus*) fruits harvested at mature unripe stage, these were procured from a farm near Belgaum. The bulbs were separated and deseeded and these. Deseeded bulbs were blanched in boiling water for 1minute. Later, jackfruit bulbs were desiccated in a tray drier at a temperature of 65°C for 24hours. The dried jackfruit bulbs were grounded to fine powder in a miniature flour mill. Mature aonla (*Emblica officinalis*) fruits were brought from a farm in Hidkal dam of Gokak taluk, Belgaum district, Karnataka, India. Fruits were washed with tap water and sliced with the help of slicing machine. The fruit slices dried in electric drier at 60°C for 4hours. The dried slices were ground in to fine powder using electric grinder further, these powders (carrot, jackfruit and Aonla) were individually sealed in aluminum foil pouches for the use in the preparation of sweet biscuits.

A fine cream was prepared by mixing sugar with dalda in one direction. Required quantity of refined wheat flour or composite flour (plus fruit or vegetable powder), salt and baking powder were sieved on the working table. Curd and cardamom flavor were added and mixed with the cream thoroughly. Refined wheat flour or composite flour was blended to the mixture and needed to soft and smooth dough. The dough was made into small but uniformly round balls and placed in the baking trays in an oven at the temperature of 200°C for 10-15 minutes. Biscuits were taken out, cooled and heat sealed in aluminum foil pouches for further studies.

T_1– Sweet biscuit (standard recipe with 100% refined wheat flour)

T_2 –90% Refined wheat flour+10% carrot powder

T_3 –80% Refined wheat flour+20% carrot powder

T_4 – 75% Refined wheat flour+25%jackfruit powder

T_5 – 50% Refined wheat flour+50% jackfruit powder

T_6 – 95% Refined wheat flour+5% amla powder

T_7 – 90% Refined wheat flour10%amla powder

Nutritional parameters

Color values: The color of the samples was measured using a Lovibond color meter (Lovibond RT300, Portable spectrophotometer, The Tintometer Limited, Salisbury, UK) fitted with 8mm diameter aperture. The instrument was calibrated using the standard black and white tiles and color was expressed in Lovibond units L* (Lightness/darkness), a* (redness/greenness) and b* (yellowness/blueness). Samples of biscuits were directly placed under the aperture of the color meter. Three measurements were performed for each sample and values were averaged.

Crude fiber (%): Crude fiber in the samples was estimated as per the Acid-Alkali method[5] and the values obtained are expressed as percent.

Reducing sugars (%): Reducing sugars in the samples were estimated as per the Dinitrosalicylic acid method[6] and the values obtained are expressed as per cent.

Total sugars (%): The total sugar content present in the products were estimated by the same method as in case of reducing sugar after inversion of the non- reducing sugar using dilute hydrochloric acid[7] and the values obtained are expressed as percent

Non-reducing sugars (%): The per cent non- reducing sugars was obtained by subtracting the value of reducing sugar from that of total sugars.

Moisture content: Moisture content was analysed using Ohaus moisture analyser and recorded in percentage.

Water activity: Water activity of biscuits was measured by using water activity meter (Model: Novasina AG, Switzerland). Water activity of biscuits was measured by placing six biscuits in the sample chamber and observation was recorded.

Sensory evaluation: Sensory evaluation was carried by five semi-trained panel on five point hedonic scale. The data on the nutritional parameters and sensory characters recorded are further subjected to Completely Randomised Design with seven treatment and three replications.

Results and discussion

The treatment (T_1) recorded maximum of L* value (64.76) and it was found to be non-significant with T_2, T_6, and T_7.The minimum of L* (52.66) was recorded in the biscuits with 50% refined wheat flour substituted with 50% of jackfruit powder (T_5). This may be due to the fact that the biscuits in T_1 was prepared from pure refined wheat flour (Maida) and in other treatments contained minimal incorporation of horticultural produce leading to higher L* value as compared to the other treatments. The significantly maximum a* value of 15.63 was registered in the biscuit with 80% refined wheat flour substituted with 20% of carrot powder (T_3) and it was on par with T_2(14.53). The T_3 (80% refined wheat flour+20% carrot powder) showed the maximum b* value of 33.27. However, the less b* value (19.25) was found in T_1 (100% refined wheat flour) and it was on par with T_6.The result indicated that the incorporation of horticultural produce in biscuit caused darkening effect, reduced the lightness (in case of jackfruit) and turned them more yellowish (in case of carrot) due to the influence of the carotene pigments present. Biscuits were slightly reddish grey and more yellowish in color, compared to the control treatment. Earlier studies indicate that darkness in biscuit may have also resulted from Maillard reaction between sugar and protein, due to inclusion of fruits containing sugar (Table 1).[7]

Table 1 Effect of treatments on the color (L* a* b*) values, moisture content and water activity of sweet biscuit

Treatment	*L**	*a**	*b**	Moisture(%)	Water activity(aw)
T_1-100% RWF(control)	64.76	9.45	19.25	3.73	0.31
T_2-90% RWF+10% CP	62.74	14.53	22.13	5.40	0.35
T_3-80% RWF+20% CP	60.67	15.63	33.27	5.16	0.34
T_4-75% RWF+25% JP	58.52	11.56	25.26	3.73	0.35
T_5-50% RWF50%+JP	52.66	12.34	28.62	4.63	0.38
T_6-95% RWF+5% AP	63.63	10.14	20.01	5.06	0.35
T_7-90% RWF+10% AP	62.38	11.43	21.25	6.43	0.37
Mean	**60.76**	**12.15**	**24.25**	**4.88**	**0.35**
S.Em ±	**0.873**	**0.490**	**0.436**	**0.511**	**0.002**
C.D at 1%	**3.675**	**2.063**	**1.837**	**2.154**	**0.010**

RWF, refined wheat flour; CP, carrot powder; JP, jackfruit powder; AP, aonla powder L* lightness, a* redness, b* yellowish

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The moisture content and water activity values of the biscuit samples were in the range of 6.43 to 3.73% and 0.38 to 0.31%, respectively. Although there were significant differences among the treatments, the moisture content and water activity values of the biscuits indicate that the values are in the safe range of storage quality. The water activity values of biscuits are below the recommended range of water activity growth of bacteria (aw<0.91) and moulds (aw<0.81). In addition to influencing microbial spoilage, water activity play a significant role in determining the activity of enzymes and vitamins in the foods and can have a major impact on their color, taste and aroma.[7]

Initial and three months after storage the total sugar content of all treatment biscuits decreased from range of 13.08 to 9.97% and 12.22 to 9.30%, respectively. Whereas the control treatment biscuits had higher sugar content initially as well as throughout the storage period than the biscuits in which fruit and vegetable powders were incorporated. The sugar content treatment biscuits decreased as the level of incorporation of quantity of fruits and vegetable increased. Results showing similar trend of higher total sugar and carbohydrates in control treatment than in composite flour biscuits have also been reported.[8–10] This may be due to the interaction of added sugar with the chemical components of flour and flour mixtures during the process of baking. However, the process of loss of sugar in treatments incorporated with fruits and vegetable powders in unclear. Among all the treatments, the T_7 (90 per cent wheat flour+10 percent aonla powder) recorded the lowest sugar content. Higher acid content in aonla might have caused hydrolysis of sugars leading to decrease in their concentration. Reducing and non-reducing sugars content in biscuits also followed the same trend (Table 2)(Table 3).

Table 2 Effect of treatments and storage period on the reducing and non reducing sugar of sweet biscuits

Treatments	Reducing sugar(%)				Non reducing sugar(%)			
	Initial	1MAS	2MAS	3MAS	Initial	1MAS	2MAS	3MAS
T_1-100% RWF (control)	10.74	10.64	10.50	10.10	2.34	2.24	2.18	2.12
T_2-90% RWF+10% CP	10.62	10.58	10.40	10.08	2.28	2.18	2.10	2.01
T_3-80% RWF+20% CP	10.70	10.61	10.48	10.00	2.30	2.20	2.14	2.11
T_4-75% RWF+25% JP	9.57	9.55	9.50	9.00	1.68	1.58	1.50	1.47
T_5-50% RWF+50%JP	9.30	9.10	8.98	8.68	1.20	1.10	1.00	0.99
T_6-95% RWF+5% AP	9.00	8.98	8.85	8.50	1.14	1.11	1.01	0.98
T_7-90% RWF+10% AP	8.85	8.78	8.65	8.40	1.12	1.01	0.99	0.90
Mean	**9.82**	**9.74**	**9.62**	**9.25**	**1.72**	**1.63**	**1.56**	**1.51**
S.Em±	**0.22**	**0.05**	**0.04**	**0.31**	**0.04**	**0.04**	**0.03**	**0.031**
C.D. at 1%	**0.93**	**0.24**	**0.20**	**1.31**	**0.20**	**0.18**	**0.13**	**0.130**

RWF, refined wheat flour; CP, carrot powder; JP, jackfruit powder; AP, aonla powder; MAS, month after storage

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Table 3 Effect of treatments and storage period on the total sugar and crude fiber content of sweet biscuit

Treatments	Total sugar(%)				Crude fiber(%)
	Initial	1MAS	2MAS	3MAS	3MAS
T_1-100% RWF(control)	13.08	12.88	12.68	12.22	0.35
T_2-90% RWF+10% CP	12.90	12.77	12.50	12.09	0.65
T_3-80% RWF+20% CP	13.00	12.81	12.62	12.11	0.95
T_4-75% RWF+25% JP	11.25	11.13	11.00	10.47	0.62
T_5-50% RWF+50%JP	10.50	10.20	9.98	9.67	0.90
T_6-95% RWF+5% AP	10.14	10.08	9.86	9.48	0.52
T_7-90% RWF+10%AP	9.97	9.79	9.64	9.30	0.69
Mean	**11.54**	**11.38**	**11.18**	**10.76**	**0.66**
S.Em±	**0.059**	**0.044**	**0.037**	**0.032**	**0.009**
C.D. at 1%	**0.249**	**0.188**	**0.159**	**0.137**	**0.041**

RWF, refined wheat flour; CP, carrot powder; JP, jackfruit powder; AP, aonla powder; MAS, month after storage

With regard to crude fibre content, the biscuits involving treatment T_3 (80% refined wheat flour+20% carrot powder) were found to have 0.95percent and it was on par with T_5 (0.90%). The crude fibre content of composite biscuits increased with the increase in the level of substitution of fruits and vegetable powder, this is in consistent with results of.[11] The lowest crude fibre content (0.35%) was found in T1 with 100percent refined wheat flour as the refined wheat flour is a poor source of fibre in comparison to fruits and vegetable powders. It is also that, wheat flour is a poor source of fibre due to the fact that bran fractions of wheat that are high in total dietary fibre contents are removed during the milling process.

A decreasing pattern in scores for overall acceptability with advancement in storage was noted in all the treatment biscuits. The highest score (4.58) for overall acceptability was noted initially in T_4(75% refined wheat flour+25% jackfruit powder) which decreased to 4.16 after three months of storage but treatment still remained highest scoring throughout the storage. The decrease in overall acceptability with the progress in storage period might be due to decrease in color and appearance, crispness, taste and flavor. The least score was observed in T_5 (50% refined wheat flour+50% jackfruit powder) in the fresh sweet biscuits (3.78) as well as after its storage for 1month (3.45), 2months (3.45) and 3months (3.45). This could be due to unattractive color and unpalatable taste and flavor at higher proportion of jackfruit powder. Similar type of observation in composite biscuits has been noted by some scientists[12] with black carrots;[13] with mango seed kernel;[14] with chick pea and plantain powder;[15] with potato flour (Table 4).

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Table 4 Effect of treatments and storage period on the overall acceptability of sweet biscuits

Treatments	Overall acceptability (score out of 5)			
	Initial	1MAS	2MAS	3MAS
T1-100% RWF (control)	4.53	4.36	4.3	4.06
T2-90% RWF+10% CP	4.53	4.3	4.23	3.86
T3-80% RWF+20% CP	4.4	4.27	4.06	3.83
T4-75% RWF+25% JP	4.58	4.42	4.35	4.16
T5-50% RWF+50% JP	3.78	3.45	3.45	3.45
T6-95% RWF+5% AP	4.23	4.15	4.1	3.83
T7-90% RWF+10%AP	4.24	4.03	3.96	3.56
Mean	**4.33**	**4.14**	**4.06**	**3.82**
S.Em±	**0.111**	**0.122**	**0.093**	**0.051**
C.D. at 1%	**0.47**	**0.516**	**0.394**	**0.215**

Conclusion

The influence of sweet biscuits prepared by incorporating powders of jackfruit (25%, 50%), aonla (5%, 10%) and carrot (10%, 20%) at different proportions to the standard recipe on various nutritional and sensory parameters was assessed at fresh and during storage. The nutritional parameters, viz., reducing sugar, non-reducing sugar and total sugar decreased from 9.82 to 9.25 percent, 1.72 to 1.51 percent and 11.54 to 10.76 percent, respectively during storage period of three months as revealed by their mean values and color values (L*, a*, b*) increases the horticultural produce L* value decreased from 64.76 to 52.66, respectively a* and b* values are increased from 9.45 to 15.63 and 19.25 to 33.27. Moisture content and water activity were increased from 4.88 to 5.62 per cent and 0.35 to 0.47, respectively. The crude fiber content increased from 0.35 (T_1) to 0.95 per cent (T_3) and it increased with the increase in the incorporation of horticultural produce in biscuits.

The higher sensory score was noted initially in T_4 (75% Refined wheat flour+25% jackfruit powder) and this treatment remained high scoring throughout the storage. The decrease in sensory score with the progress in storage period might be due to decrease in color and appearance, crispness, taste and flavor as they became old. Significantly least score was observed in T_5 (50% Refined wheat flour+50% jackfruit powder) in the fresh sweet biscuits as well as after its storage for 1, 2, and 3months. The lower scores in this treatment could be due to unattractive color and unpalatable taste and flavor at higher proportion of jackfruit powder.[16,17]

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None.

Conflict of interest

Author declares that there is no conflict of interest.

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