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Quality evaluation and storage studies on traditional nuggets (*wari*) enriched with exotic vegetables broccoli and kale grown with organic and inorganic inputs

Preeti Chaudhary and Ranjana Verma

Abstract

The present research was carried out to formulate traditional nuggets (*wari*) from black gram paste and supplemented with 5, 10 and 15 per cent broccoli and kale grown with organic and inorganic inputs. The developed nuggets were analyzed to determine their rehydration characteristic, sensory and shelf life quality. The results of study revealed that the rehydration ratio in nuggets prepared by using broccoli and kale varied significantly with level of supplementation and storage. As addition of broccoli and kale in powder form changed colour and texture of the nuggets adversely. Nuggets prepared with same supplementation levels but in chopped form had better physical appearance over others. Nuggets curry prepared from organic broccoli and kale rated significantly ($p < 0.05$) better in terms of overall acceptability when compared with that prepared from nuggets prepared from inorganic counterparts. The sensory scores of nugget curry prepared from stored nuggets declined significantly with increase in storage period of nuggets but ranged between “liked moderately” and “liked very much” on nine point hedonic scale. This study provided a novel legume based product in form of vegetables enriched nuggets and allows the availability of the perishable vegetables during offseason.

Keywords: Nuggets (*wari*), broccoli, kale, rehydration characteristics, self-life, sensory evaluation

Introduction

Himachal Pradesh, a northern mountainous state of India, is famous for its rich diversity in terms of traditions, culture, dress, language, and food [1]. The rich culture and traditions of Himachal Pradesh are reflected in its cuisine that encompasses a wide range of traditional foods prepared and consumed by the people. However, production of these traditional foods has been limited to household levels. Generally, for production of these foods locally available substrates are used [2].

Vegetables of the *Brassica* group are the most commonly grown and consumed on a global scale. Certain cruciferous vegetables of the genus *Brassica* including cauliflower, broccoli, cabbage and Brussels sprouts have been studied extensively as they are rich sources of antioxidants including carotenoids, tocopherols, ascorbic acid, and flavonoids, vitamins, fibre and contain little fat and energy [3]. Organically grown/ labeled produce is considered to be healthier and nutritious than conventionally grown produce by the consumers. Studies assessing consumer perceptions of organic produce have detected opinions that organic produce is safer, more nutritious and better tasting than conventionally grown produce [4].

The product like nuggets (*wari*) prepared from black gram or green gram, is one of the most common traditional preparations in Himachal Pradesh as well as in India and is used throughout the year [5]. It is fermented foods derived from an important part of the human diet. Research studies indicate that nugget is a partially fermented legume-based savoury which is manufactured on small scale in rural areas of Northern India and is used as adjunct in curries. Nugget is prepared from batter of split black gram or green gram dhal and is seasoned with various spices and condiments like dried fenugreek leaves, coriander powder, cumin seeds, red chilli powder and black pepper [6]. Dehydrated nuggets are easy to prepare, require no costly machinery for manufacture and have a longer shelf life. Successful attempts have been made to develop nuggets from vegetable crops like potato, but studies reporting the use of broccoli and kale vegetables for formulation of nuggets are scanty. Considering these facts, this research study had been planned with the objective to developed legume (Black gram) based nuggets supplemented with varying proportion of organically and inorganically grown broccoli and kale in chopped and powdered form.

The developed products were analyzed for the rehydration ratio, shelf stability and sensory acceptability.

Material and Methods

Fresh and optimally mature organically grown samples of broccoli (var *Palam Samridhi*) and kale (var *DSK-I*) were procured from the Department of Organic Agriculture, CSKHPKV, Palampur whereas, same varieties of broccoli and kale were grown conventionally using inorganic inputs. After sorting, the material was washed under running water and trimmed.

Preparation of raw materials

Nuggets were prepared by incorporating organically and inorganically grown broccoli and kale in chopped and powdered form. The raw vegetables were chopped finely and dried at 60 °C in tray drier until constant weight was achieved. The dehydrated vegetables were divided into lots. One lot was kept as such and other was ground to achieve fine powder. The dehydrated chopped and powdered samples were stored in air-tight containers for further use. The black gram *dhal* was soaked in double the amount of water overnight and excess water was drained. The soaked *dhal* was wet ground and made to smooth paste using a mixer and grinder. The thick wet paste was whisked continuously in one direction to allow desired aeration and make the paste light and fluffy.

Formulation of Nuggets

Nuggets were formulated by incorporating the powdered and chopped dehydrated broccoli and kale in varying proportions (5, 10 and 15 %) with the ground *dhal*. The mixture was again whipped in one direction till smooth and fluffy.

Processing method

The prepared mixture was taken in hand and divided into small balls weighing 30-40 g and spread on trays with oil smeared on them, maintaining a distance of 1-2 inch between nuggets. The trays were then kept in hot air cabinet drier and dried at 60 ± 5 °C for 14-16 hours or until constant weight was achieved. The nuggets prepared without broccoli and kale were kept as control.

Rehydration ratio of nuggets^[7]

Rehydration ratio was calculated by taking the ratio of dehydrated sample to rehydrated sample. Five gram of dehydrated sample was put into a beaker to which 100 ml of cold water was added. After 20 minutes, the drained weight of the rehydrated material was taken. The rehydration ratio was calculated by the following formula.

$$\text{Rehydration ratio} = \frac{\text{Weight of the dried sample before rehydration}}{\text{Weight of dried sample after rehydration}}$$

Preparation of nuggets curry

Nuggets (30 g) were shallow fried for 45 s in a frying pan containing 60 ml of cooking oil maintained at 130 °C. The fried nuggets were taken out and kept aside and to the remaining oil, spices were added. Quantities of ingredients used for nuggets curry were: Nuggets (100 g), onion (50 g), tomato (50 g), salt (10 g), ginger paste (12.5 g), garlic paste (12.5 g), red chilli (10 g), *garam masala* (25 g), oil (50 ml), turmeric powder (5 g) and cumin seeds (10 g). Onion, ginger,

garlic and tomato paste were added and the whole mixture was fried till golden in colour. To this mixture, fried nuggets were added and cooked for 2 minutes, then water was added and the whole mixture was cooked till the nuggets became soft.

Sensory evaluation of nuggets

For evaluating the sensory characteristics of the nuggets, nine point hedonic scale was used. The scores were assigned from extremely liked (9) to disliked extremely (1)^[8].

Statistical Analysis

The data obtained from various experiments were subjected to statistical analysis using SAS 9.2 English software copyright © 2002-2008 by SAS Institute Inc., Cary, NC, USA Proprietary Software 9.2 (TS2M2) Licensed to Indian Agricultural Statistics Research Institute, Site 11601386. Differences were considered significant at the 5% significant level. Where significant effects were found, the least significant difference test (LSD) was used to locate any significant differences between the means.

Results and Discussion

Rehydration ratio of broccoli and kale nuggets

Rehydration is one way to analyze dried products. A high value of rehydration ratio means the dried product has a good quality because the pores allow water to reenter the cells^[9]. Effect of storage and treatments on the rehydration ratio of broccoli nuggets is presented in Table- 1. As is clear from the table, the average rehydration ratio of nuggets prepared with organic broccoli powder was 1.81 which was comparatively more than those prepared with chopped organic broccoli. On the contrary, the corresponding values for nuggets prepared with inorganic broccoli were 1.81 in nuggets prepared with chopped broccoli and 1.71 in nuggets prepared with powdered broccoli. With storage, the rehydration ratio varied significantly with each other with average values of 1.76, 1.66 and 1.72 after 0, 45 and 90 days of storage, respectively. Similarly, the rehydration ratio of kale nuggets as affected by storage and treatments is presented in Table 2. Maximum rehydration ratio of 2.02 was observed in nuggets prepared without kale supplementation. Among the various treatments, nuggets prepared with 5 per cent kale, irrespective of form in which it was used i.e. powder or chopped exhibited maximum rehydration ratio of 1.58 followed by in nuggets prepared with 10 and 15 per cent kale with 1.46 and 1.30 rehydration ratio. With storage, there was a significant decline in rehydration ratio where the values declined with increase in storage. Among the two treatments i.e. chopped and powdered, the nuggets prepared with chopped kale had slightly more rehydration ratio with average values of 1.57 and 1.29 in organic and inorganic kale nuggets, respectively when evaluated fresh. The corresponding values for nuggets prepared with powdered kale were 1.55 and 1.33, respectively.

The variations in the rehydration characteristics content during storage can be explained by the fact that there are considerable variations in the relative humidity of the study location of which may have impacted the moisture content in the stored nuggets. The findings of Mung bean *wadis*^[10] and potato *wadis*^[11] case also reported similar. The amount of bound water was more at lower temperatures and it decreased with an increase in temperature. This water is not available for microorganisms; so the shelf-life of *wadi* at lower

temperatures will be more than at higher temperatures [12]. Amaranthus leaves sun drying led to higher rehydration ratios than shade drying [13].

Sensory acceptability of broccoli and kale based nugget curry

Sensory tests carried out to determine the level of acceptance of legume (Black gram) based nuggets supplemented with varying proportions (5, 10 and 15 %) of organic and inorganic broccoli and kale in chopped and powdered form by panelists. The physical appearance of the nuggets prepared by using chopped and powdered broccoli and kale obtained from organic and inorganic sources revealed that as the level of supplementation of broccoli and kale powder increased in nuggets the colour of the nuggets changed from light green to dark and further darker green with 5, 10 and 15 per cent level of supplementation, respectively. On the contrary, addition of broccoli and kale in same levels but in chopped form did not affect the colour of the nuggets much.

Data of Table 3 represents the overall acceptability score of nugget curry prepared by using broccoli in chopped and powdered form. The overall acceptability scores of curry prepared with organic broccoli nuggets was slightly higher 7.72 when compared with inorganic nuggets curry with an average score of 7.68. Irrespective of the source of broccoli i.e. organic or inorganic, the overall acceptability scores of nugget curry prepared with chopped broccoli nuggets was comparatively more than that of curry prepared with powdered broccoli nuggets. During storage, the average score for overall acceptability was recorded as 7.70, 7.70 and 7.66

after 0, 45 and 90 days of storage, respectively.

Similar trends were observed in case of nugget curry prepared with kale (Table- 4). A significant difference was observed in nugget curry prepared from nuggets with 5, 10 and 15 per cent level of dehydrated kale supplementation. Among the two sources of kale i.e. organic and inorganic, nuggets curry prepared from organic kale nuggets, irrespective of chopped or powdered form, recorded maximum scores for overall acceptability than inorganic kale nugget curry. Irrespective of source of kale and treatments, the overall acceptability scores of nugget curry varied significantly with increase in storage. But the scores remained above liked very much on none point hedonic scale.

These observations establish the fact that broccoli and kale can successfully be used in the formulation of nuggets. This provides a viable option for value addition of these vegetables and also increasing the shelf life of the vegetables. The study results of *Sikut* vegetable enriched *wadis* was not significantly affected up to 9 months of storage. In the 12th month, the decrease in the overall acceptability was marginally statistically significant for *Sikut* enriched *wadis*. The *wadis* formulated with blanched vegetable recorded the highest score of 8.09 at 12 months after storage [6]. Appearance in between carrot incorporated mutton nuggets as compared to radish, capsicum and control nuggets and significantly higher scores for flavour ($P < 0.05$) and over acceptability ($P < 0.05$) were observed in between capsicum incorporated mutton nuggets as compared to carrot, radish and control nuggets [14]. Raw carrot and mashed potato chicken nuggets at 10 per cent level successfully incorporated [15].

Table 1: Effect of storage and treatments on rehydration ratio of broccoli based nuggets

Supplementation level (%)	Storage (days)	Organic		Mean	Inorganic		Mean	Overall Mean
		Chopped	Powder		Chopped	Powder		
Control	0	2.02						
5		1.65	1.71	1.68	1.7	1.61	1.65	1.67
10		1.80	1.80	1.80	1.82	1.82	1.82	1.81
15		1.60	1.92	1.76	1.92	1.71	1.82	1.79
Mean		1.68	1.81	1.75	1.81	1.71	1.76	1.76
Control	45	1.98						
5		1.64	1.69	1.67	1.69	1.60	1.66	1.64
10		1.79	1.78	1.79	1.81	1.79	1.79	1.79
15		1.55	1.88	1.72	1.85	1.69	1.74	1.55
Mean		1.66	1.78	1.72	1.79	1.69	1.74	1.66
Control	90	1.95						
5		1.63	1.68	1.65	1.67	1.54	1.61	1.63
10		1.76	1.76	1.76	1.77	1.76	1.76	1.76
15		1.54	1.86	1.7	1.87	1.66	1.76	1.73
Mean		1.64	1.76	1.71	1.77	1.65	1.71	1.72

LSD ($P \leq 0.05$) Treatments (T)- 0.02; Storage (So)- 0.01

Table 2: Effect of storage and treatments on rehydration ratio of kale based nuggets

Supplementation level (%)	Days	Organic		Mean	Inorganic		Mean	Overall Mean
		Chopped	Powder		Chopped	Powder		
Control	0	2.02						
5		1.70	1.74	1.72	1.36	1.51	1.44	1.58
10		1.60	1.50	1.55	1.30	1.42	1.36	1.46
15		1.41	1.40	1.41	1.20	1.20	1.20	1.30
Mean		1.57	1.55	1.56	1.29	1.38	1.33	1.45
Control	45	1.98						
5		1.68	1.72	1.70	1.34	1.50	1.42	1.56
10		1.64	1.48	1.56	1.29	1.43	1.36	1.46
15		1.39	1.40	1.40	1.19	1.19	1.19	1.29
Mean		1.57	1.53	1.55	1.27	1.37	1.32	1.43
Control	90	1.95						

5		1.67	1.71	1.69	1.31	1.46	1.39	1.54
10		1.58	1.47	1.53	1.26	1.38	1.32	1.42
15		1.37	1.38	1.38	1.16	1.16	1.16	1.26
Mean		1.54	1.52	1.53	1.24	1.33	1.29	1.41
LSD ($P \leq 0.05$) Treatments (T) - 0.02; Storage (So)- 0.01								

Table 3: Effect of storage and treatments on the overall acceptability of broccoli nugget curry

Supplementation level (%)	Storage (days)	Organic Broccoli		Mean	Inorganic Broccoli		Mean	Overall Mean
		Chopped	Powder		Chopped	Powder		
Control	0	7.96						
5		7.92	7.87	7.90	7.86	7.84	7.85	7.87
10		7.72	7.67	7.70	7.64	7.64	7.64	7.67
15		7.56	7.55	7.56	7.54	7.55	7.55	7.55
Mean		7.73	7.70	7.72	7.68	7.68	7.68	7.70
Control	45	7.89						
5		7.86	7.83	7.85	7.84	7.86	7.85	7.85
10		7.68	7.67	7.68	7.67	7.66	7.67	7.67
15		7.61	7.25	7.43	7.52	7.52	7.52	7.48
Mean		7.72	7.58	7.65	7.68	7.68	7.68	7.70
Control	90	7.87						
5		7.82	7.79	7.81	7.83	7.81	7.82	7.81
10		7.65	7.65	7.65	7.59	7.62	7.61	7.63
15		7.61	7.51	7.56	7.45	7.49	7.47	7.52
Mean		7.69	7.65	7.67	7.62	7.64	7.63	7.66
LSD ($P \leq 0.05$) Treatments (T)- 0.02; Storage (So)- 0.01								

Table 4: Effect of storage and treatments on overall acceptability of kale nugget curry

Supplementation level (%)	Storage (days)	Organic		Mean	Inorganic		Mean	
		Chopped	Powder		Chopped	Powder		
Control	0	7.95						
5		7.86	7.82	7.84	7.88	7.53	7.71	
10		7.62	7.64	7.63	7.82	7.75	7.79	
15		7.53	7.53	7.53	7.84	7.55	7.70	
Mean		7.67	7.66	7.67	7.85	7.61	7.73	
Control	45	7.89						
5		7.83	7.8	7.85	7.85	7.49	7.67	
10		7.61	7.64	7.63	7.8	7.62	7.71	
15		7.51	7.52	7.52	7.82	7.5	7.66	
Mean		7.65	7.65	7.65	7.82	7.54	7.68	
Control	90	7.86						
5		7.8	7.81	7.81	7.82	7.45	7.64	
10		7.54	7.6	7.57	7.78	7.59	7.69	
15		7.49	7.5	7.50	7.8	7.49	7.65	
Mean		7.61	7.64	7.62	7.8	7.51	7.66	
LSD ($P \leq 0.05$) Treatments (T)- 0.02; Storage (So) - 0.01								

Conclusion

The results of the present investigation present an alternative method for value addition of *broccoli and kale* vegetables. The formulation of nuggets enriched with powdered and chopped dehydrated broccoli and kale in varying proportions (5, 10 and 15 %) may provide an option for its production at small scale considering the fact the inputs for the production of this product are very minimal and thus it can be a viable economic activity for households, Small Help Groups and Non-Governmental Organizations. Nuggets prepared with same supplementation levels but in chopped form had better physical appearance over others. Nuggets curry prepared from organic broccoli and kale rated significantly better in terms of overall acceptability when compared with that prepared from nuggets prepared from inorganic counterparts. The sensory scores of nugget curry prepared from stored nuggets declined significantly with increase in storage period of nuggets. Broccoli and kale are exotic vegetables and rich in several health promoting nutrients, there is need to devise value addition methods for these vegetables. The study also

provides a novel legume based product in form vegetables enriched nuggets and allows the availability of the perishable vegetables during offseason.

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