Standardization, Characterization and Shelf Life Studies on *Sandge*, a Traditional Food Adjunct of Western India

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Abstract*—Food adjuncts are an assortment of items that add variety, spice and crunch to the common menu. Maharashtra is a western state of India. Traditional food adjuncts of Maharashtra include sandge, sandaya, kurdaya, papad, pickles, chutney and chutney powders,wadi etc. Studies were undertaken to standardize the recipe, process parameters and select suitable packaging materials for Sandge(a dried vegetable product made from carrot and /pumpkin/ bottle gourd or radish as well as okra, coriander leaves, sesame seeds, green chilies and salt). Five different combinations using carrot (80%, 60%, 40%), pumpkin / bottle gourd (20%, 40%) each and other ingredients (20%) were prepared and evaluated for sensory characteristics. The product made with carrot (80%) and other ingredients (20%) scored the best. The product from standardized recipe was dried at three different temperatures (45ºC, 50ºC, 55ºC). 50 ºC drying temperature was found to be optimum based on the sensory evaluation. The dehydrated sandge were analyzed for their physico-chemical characteristics, packed in PET/PE and PET/Met.poly/ PE pouches and stored under ambient temperature conditions for a period of 90 days. The decrease in sensory scores was found to be significant in PET/PE packed sandge while the same packed in PET/Met.poly/ PE pouches was found to be acceptable even after 90 days of storage. The colour changes over the storage period were also measured using Lovibond Tintometer.*

Keywords— adjunct, carrot, drying, packaging, nutritional composition,sandge, sorption isotherm , sensory values.

I. INTRODUCTION

Indian cuisine consists of a wide spectrum of food cultures with distinctive regional difference and preferences [1]. Food adjuncts are an assortment of items that are consumed as an accompaniment to the staple food [2]. They add variety, spice and crunch to the common menu with standard items. Indian cuisine includes a variety of food adjuncts which can be broadly classified into the pickles, chutneys, dry chutney powders, preserves like amlamurabba , dried vegetable products such as *sandge* and *bharwanmirch*, dry semi processed adjuncts like *papad, urad mung or channabadi*, extruded products from cooked starchy materials such as *Kurdai* from wheat , *chikwadi* from rice or sorghum, and many more local varieties, which are consumed after frying or are made into curry [3].

Maharashtra is a western state of India. Maharashtrian cuisine is rich and diverse ranging from mild vegetarian food of Pune to spicy dishes from Kolhapur and sea food of kolis and konkanis [4]. Traditional food adjuncts of Maharashtra include *sandge, sandaya, kurdaya, papad,* pickles, chutney and chutney powders,*wadi* etc. [5]. These food items are relished along with the traditional staple diet of *roti* (wheat bread), rice/*khichdi* (cooked rice+pulses), *dal*(curry made of pulses) and *sabzi* (cooked vegetable). Traditionally these products were prepared at household level, by making use of regionally and seasonally available ingredients. Some of the products like wet chutneys and some pickles would have a shelf life of 8-15 days, but most of the products were prepared to ensure the supply throughout the year. Seasonal perishable vegetables would be converted into shelf stable pickles, sauces and spreads. Preparation of dried products like *papad, wadi*, chips etc. has been a regular activity in early summer, and the practice is still alive in semi urban and rural setup. Increasing urbanization, social changes, and presence of large section of middle class working women with enhanced purchasing power in cities has created the need for supply of these adjuncts as a consumer item. They are being prepared as a local branded/non-branded product at a cottage /small scale industry by needy women as per seasonal demand and sold to nearby grocery outlets or as door to door service. The

quality parameters for most of these products are not standardized, documented or monitored by any regulatory bodies [3].

*Sandge*are dried vegetable products made by mixing grated carrots and /pumpkin/ bottle gourd or radish with okra, coriander leaves, sesame seeds, green chilies and salt; making it into small balls and drying in hot sun for two to three days. The dried balls are then fried and served along with rice, khichdi or added to curries at the time of scarcity of vegetables [6].*Sandge* available in market from March to May contain varied ingredients and have short shelf life with poor packaging.

1.1 Nutritive importance

Although consumed in small portions, adjuncts play an important role in nutrition and health. A major ingredient used in *sandge* formulations is carrot. Carrot is a root crop. It is widely used in various vegetable preparations, pickles and sweet dishes [7]. According to ministry of agriculture, Govt. of India, in the year 2012-13, the production of carrot in India was 11.47 lakh metric tonnes. There is enough production, but the seasonal availability restricts its use to the season when it is available in plenty [8]. People all over the world prefer the consumption of carrot due to its high nutritive value and medicinal uses for its anti-cancerous property [9]. Carrot has the highest β- carotene content (8285µg/100gm) among foods [10]. Carrots are rich in anti-oxidants (falcarinol), vitamins especially vit. C and pyridoxine (vit. B6), folic acid, thiamin, pantothenic acid and contain good levels of minerals like copper, calcium, potassium, manganese and phosphorus [11]. Leafy vegetables such as coriander leaves are inexpensive , contain low levels of fat and are rich sources of carotene, ascorbic acid, folic acid, riboflavin, fiber and minerals like calcium, iron and phosphorus [12-15] . Sesame seeds add a nutty taste and crunch to many Asian dishes [16]. They are an important source of fat, protein, dietary fiber, vitamins such as niacin, folic acid, thiamin, pyridoxine, riboflavin and minerals such as calcium, copper, manganese, magnesium, iron, zinc,and selenium. They are also rich source of omega-6-fatty acids, antioxidants such as sesamol and sesaminol [11].

This study was undertaken to standardize the recipe and the process parameters as well as to evaluate nutritive value of the product during storage using different packaging materials.

II. MATERIALS AND METHODS

Vegetables like carrot (*Daucuscarota*), pumpkin (*Cucurbita moschata*), bottle gourd (*Lagenaria vulgaris*), coriander leaves (*Coriandrumsativum)*, fenugreek leaves (*Trigonellafoenum-graecum)*, green chilies (*Capsicum annum*), okra were procured from the local vegetable market. All the vegetables were washed under running water till completely free of dirt. Carrots, bottle gourd and pumpkin were peeled and grated using food processor (Inalsa, India). Coriander and fenugreek leaves were separated from the stems, dried on muslin cloth till surface moisture was evaporated and finely chopped. Okra pods and green chilies were chopped and ground to a fine paste.

Sesame seeds(*Sesamumindicum*) and common salt were procured from the supermarket. Sesame seeds were also cleaned and salt was checked for any impurities.

2.1 Standardization of recipe and process parameters

*Sandge*recipe was formulated using various levels of carrot (20-80%), okra, green chilies, coriander leaves, sesame seeds and salt and the best product was obtained for a combination of carrot (80%), okra (9%), green chilies (3.5%), coriander leaves (2%) , sesame seeds (3.5%) and salt (2%). For incorporation of either pumpkin or bottle gourd in the recipe, *sandge* formulation was made using pumpkin / bottle gourd at 20% or 40% levels each, while the levels for carrot were maintained at 60% or 40% respectively. The recipe made with carrot at 80% level was taken as control. The five samples were prepared with the given composition and dried in a tray dryer (SM Scientech, Kolkata) at 50°C till constant weight was obtained. Sensory evaluation was performed using nine point hedonic scale with 1 - dislike extremely to 9 - like extremely for the samples by a semi-trained panel of 10 judges [17] . The panelists were earlier made to acquaint themselves with various samples of *sandge* from the market. The recipe selected on the basis of the sensory analysis was also tested at three different drying temperatures (45ºC, 50ºC, 55ºC). Results of the sensory analysis standardized 50°C as the optimum drying temperature for the recipe. The selection of drying temperature of 50°C has been in consensus with Kaur *et al*. [18].

2.2 Physico-chemical analysis

The standardized samples of *sandge* were analyzed in triplicate for physico-chemical characteristics .Moisture, crude fat, total protein, crude fiber, ash, carotene and salt content were estimated using standard methods [19]. Carbohydrates were estimated by the difference method. Calcium was estimated by gravimetry while iron by spectroscopy using aElico model SL-177 UV-visible spectrophotometer. Energy values were calculated by the standard method of summing up the values obtained and multiplying the quantity of carbohydrate and protein per

100gm by 4kcal and that of fat per 100gm by 9kcal respectively.

2.3 Sorption studies

Moisture sorption studies were conducted on the standardized samples of *sandge* by keeping 5gm of each of the sample in separate desiccator maintained at different relative humidities e.g.10% RH, 30%RH, 40%RH, 50%RH, 60% RH, 70%RH and 90%RH, using varying normality Sulphuric acid solutions at 25°C [20].Sample weights were noted at regular intervals till there was no further loss or gain in weight .Adverse changes like softness, sogginess, discoloration and mold growth were also noted from time to time. Critical moisture content and equilibrium moisture content were determined from the sorption isotherm.

2.4 Storage studies

Sandge samples (25gm each) were packaged in PET/ PE (12 µ PET/50 µ PE) and PET/metallized polyester/polythene (10µ/10µ/37.5µ) laminate pouches (10 cm x 10 cm). The packaged samples were kept under ambient temperature (15-35°C) conditions for a period of 90 days. The samples were drawn at an interval of 15 days and evaluated for the sensory quality and compared with a freshly prepared sample. The samples were evaluated for color units of Red, Yellow and Blue using Lovibond Tintometer (model E).

2.5 Statistical analysis

The data were expressed as mean± S.D. Statistical analysis was carried out with SPSS version 21.0 using one-way ANOVA using followed by Tukey's post hoc test for significance ($P \leq 0.05$).

III. RESULTS AND DISCUSSION

3.1 Standardization of recipe of *Sandge*

Results of the sensory evaluation from Table 1 indicated that among the formulations, the scores for colour ranged between 5.4±0.97 and 8.6± 0.52. Appearance scores were found to be in the range of 5.9±0.99 and 8.1±0.74, flavour values ranged between5.9±0.99 and 8.2±0.79, scores for texture between 4.9±0.74 and 8.0±0.82, taste scored between 4.7±0.82 and 8.1±0.71, while overall acceptance levels varied between 5.2±0.92 and 8.2±0.63. Maximum and significantly higher scores for all the parameters i.e. colour, appearance, flavour, texture, taste and overall appearance were obtained for sample containing 80% carrot. The addition of bottle gourd or pumpkin at a level of 40% affected all the parameters more significantly than at a level of 20%. Also the *sandge* with pumpkin or bottle gourd at 40% were found to be more salty and less crispy. The higher moisture content and low fibre in pumpkin (92% moisture content, 0.5% fibre) and in bottle gourd (96% moisture content, 0.6% fibre) than in carrot (88% moisture content, 2.6% fibre) [21]might be responsible for the saltiness and less crispiness in the product. The higher carotene content of carrots (5.33mg/100g) than in pumpkin (50µg/100g) and in bottle gourd (0 µg/100g) imparted bright red colour to the product. The process for the preparation of standardized *Sandge* is presented in Fig. 1.

3.2 Physico-chemical properties of *Sandge*

The proximate composition of standardized *sandge* are reported in Table 2 .Moisture content in standardized sample prior to drying was 92.43% which reduced to 7.46% after drying at 50ºC. Crude fat in *sandge* was found to be 7.12%. Tadesse, *et al*. [22] reported the crude fat content of solar dried carrots to be 2.49% on db. The higher fat content of *sandge* might be due to the presence of sesame seeds having crude fat content (43-50%) [23]. The protein content of standardized *sandge* is 9.23%. The protein content of solar dried carrots is 5.25%. The increase in protein may be because of higher protein content of sesame seeds (15-20%) and dried okra (16.9-18%) [24]. Total ash is found to be 20.05%, crude fiber 2.79% in the standardized *sandge*. The higher amount of vegetables might be responsible for the higher carbohydrate content of 56.14%.

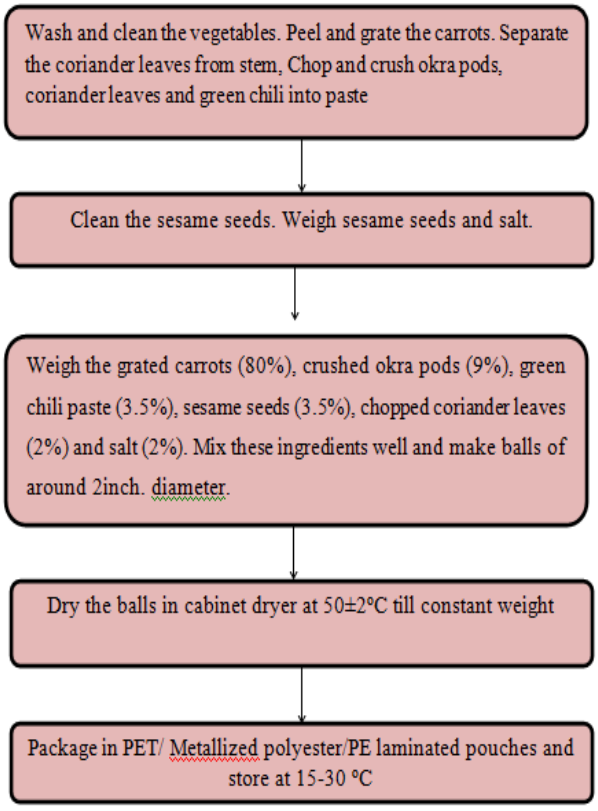

Fig.1: Standardized process for Sandge preparation

Fig. 2: Sandge samples in trays for drying

Table 1. Sensory scores for selection of carrot and/pumpkin and bottle gourd (n=10)

Parameter	Scores				
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Colour	8.6± 0.52	7.7±0.95	6.6±0.97	7.2±0.92	5.4±0.97
Appearance	8.1±0.74	7.7±0.68	6.5±0.97	7.2±0.79	5.9±0.99
Flavour	8.2±0.79	7.6±0.97	6.6±0.97	7.1±0.57	5.9±0.99
Texture	8.0±0.82	7.3±0.82	6.1±0.74	6.9±0.88	4.9±0.74
Taste	8.1±0.71	7.3±0.68	5.8±0.63	7.0±0.94	4.7±0.82
Overall appearance	8.2±0.63	7.7±0.82	5.9±0.88	7.1±0.57	5.2±0.92
Remarks	Good taste, texture , colour and flavour	Colour pale, mild flavour, less crispy	Colour pale, less crispy, slightly salty	Colour pale, mild flavour, less crispy	Less crispy and more salty

Values are mean±S.D.
Sample 1: carrot 80%+ other20%
Sample 2: carrot60%+ pumpkin(20%)+other 20%
Sample 3: carrot 40%+ pumpkin (40%) + other 20%
Sample 4: carrot 60%+ bottle gourd (20%) + other 20%
Sample 5: carrot 40%+ bottle gourd (40%) + other 20%

Table 2.Physico-chemical characteristics of freshly prepared Sandge (per 100g)

Parameter (g)	***Sandge***
Moisture	7.46± 0.07
Crude fat	7.12±0.10
Ash	20.05± 1.14
Total protein	9.23±0.11
Crude fiber	2.27±0.09
Carbohydrates	56.14
Energy (kcal)	325.6
Salt (NaCl)	10.24± 0.18
Carotene (mg)	5.93 ± 0.17
Vit.C (mg)	7.72±0.12
Calcium (mg)	2.79± 0.16
Iron (mg)	32.95±1.19

Values are average of three replicates± S.D.

3.3 Moisture sorption isotherm

Moisture sorption isotherm was plotted for *sandge* as represented in Fig.3. The product had an initial moisture content of 7.57%, which corresponds to 42% RH. The critical moisture content was found to be 13.5%, which corresponded to 53%RH, making it unstable at higher relative humidities, being hygroscopic in nature. It gained moisture quickly, became soft and discolored at RH above 70%.

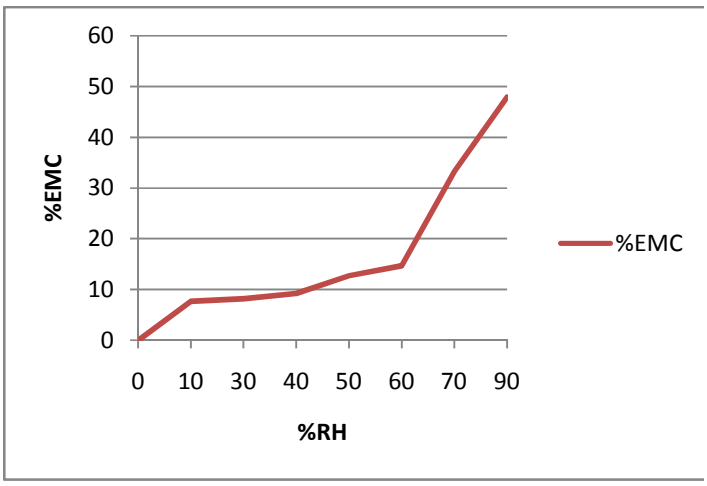

Fig.3: Moisture sorption isotherm for Sandge using sulphuric acid solutions of various RH

3.4 Storage studies

Table 3 indicates the changes in sensory scores of sandge during storage at ambient conditions for a period of 90 days.During the storage period of 90days, it was observed that the overall sensory quality of *sandge* was 8.7(excellent) on the 0 day which decreased to 1.7 (bad) for PET/PE packaged samples, whereas for PET/Met.Poly/PE packaged sample it was 8.1(very good) after 90days. The samples packaged in PET/Met. Poly /PE laminates showed marginal changes in colour, appearance, flavour, texture and taste during the storage study, but the PET/ PE packaged samples had significant changes in all the parameters after a storage period of 30 days. After 45 days,

the quality of the PET/ PE packaged samples was unacceptable. The samples packaged in PET/Met poly /PE remained in acceptable conditions even after 90days storage. It was statistically proved that the *sandge* packaged in PET/PE packaging material showed significant ($P \leq 0.05$) decrease in all the quality parameters where as for the PET/Met. Poly/PE, except for texture, the values for all the sensory parameters were not significantly ($P > 0.05$) affected. Similar results on metallized polyester packaging were obtained for the storage studies conducted on curry leaves chutney powder by Rao *et al*. [25] and on the flaxseed chutney powder by Satyanarayana*et al*.[26].

Table 3: Sensoryscores of sandgeduring storage at ambient temperature conditions for 90 days (n=10)

parameters	**PET/ PE**							**PET/Met poly/PE**						
	0	**15**	**30**	**45**	**60**	**75**	**90**	**0**	**15**	**30**	**45**	**60**	**75**	**90**
Colour	8.7±0.48[a]	8.5±0.71[a]	7.8±0.92[a]	5.3±0.95[b]	3.9±0.74[c]	2.6±0.84[d]	1.7±0.66[d]	8.7±0.48[a]	8.7±0.48[a]	8.4±0.70[a]	7.7±0.68[a]	7.4±0.84[a]	6.8±0.79[a]	6.5±0.97[a]
Appearance	8.4±0.84[a]	8.3±0.82[a]	7.5±0.97[a]	5.7±0.82[b]	4.9±0.74[b]	3.7±0.82[c]	2.0±0.67[d]	8.7±0.48[a]	8.4±0.70[a]	8.2±0.63[a]	7.4±0.84[a]	7.3±0.82[a]	6.8±0.79[a]	6.2±0.84[a]
Flavour	8.7±0.48[a]	8.5±0.71[a]	7.7±0.68[a]	6.5±0.71[b]	5.5±0.53[c]	3.7±0.68[d]	1.8±0.42[e]	8.7±0.48[a]	8.7±0.48[a]	8.6±0.52[a]	8.1±0.88[a]	7.8±0.79[a]	7.5±0.53[a]	7.3±0.68[a]
Texture	8.7±0.48[a]	8.4±0.70[a]	7.5±0.71[a]	5.8±0.92[b]	4.6±0.52[c]	2.5±0.71[d]	1.5±0.53[e]	8.7±0.48[a]	8.5±0.53[a]	8.1±0.57[a]	7.8±0.63[a]	7.6±0.52[a]	6.9±0.57[b]	6.5±0.53[b]
Taste	8.6±0.70[a]	8.2±0.79[a]	7.3±0.82[a]	6.7±0.95[a]	3.8±0.63[b]	2.5±0.53[c]	1.4±0.52[d]	8.7±0.48[a]	8.2±0.42[a]	7.6±0.52[a]	7.2±0.92[a]	7.1±0.88[a]	6.9±0.74[a]	6.7±0.95[a]
Overall appearance	8.7±0.48[a]	8.2±0.79[a]	7.3±0.68[a]	6.5±0.71[a]	4.5±0.97[b]	3.1±0.57[c]	1.7±0.48[d]	8.7±0.48[a]	8.5±0.53[a]	8.3±0.48[a]	8.3±0.48[a]	8.3±0.48[a]	8.2±0.42[a]	8.1±0.57[a]
Remarks	Bright red colour, fresh aroma, crispy texture	Bright red colour, fresh aroma, crispy textur	Slight colour change,	Slightly soft, colour brownish red, flavour good	Colour brownish, texture soft, flavour change	Colour brownish, texture soft, bad odour	Colour brownish, texture more softer,bad odour	Bright red colour, fresh aroma, crispy textur	Bright red colour, fresh aroma, crispy textur	Bright red colour, fresh aroma, crispy textu	Slight change in colour, good flavour, taste	Slight change in colour, good flavour, taste	Slight change in colour, good flavour, taste	Slight change in colour, good flavour, taste

Similar superscripts indicate non-significant difference at P>0.05
Values are mean±S.D.

Tintometer colour readings for *sandge* samples packed in PET/PE and PET/Met. Poly/PE measured using Lovibond tintometer model E have been presented in Table 4. Tintometer colour units for Yellow and Blue showed changes over the entire storage period of 90 days, except for Red which remained almost constant. The degradation of colour was more in PET /PE packaged *sandge* as compared to the one in PET/Met.poly/PE pouch. For the product

packaged in PET/PE ,the units for dullness(the least value among R, Y, B) and yellowness increased, indicating colour fading, whereas the products packaged in PET/Met. Poly/PE showed a marginal increase in the units of dullness and yellowness indicating very little colour change. The changes may be contributed to the increase in non-enzymatic browning and decrease in carotenoids upon exposure to light during storage [27].The changes in colour units had significant effect on the quality of the product. Rao, *et al*. [28] also observed the effect of colour changes measured using Lovibond Tintometer on the quality of tomato powder and instant tomato pickle mix while Khedkar*et al*. [29] studied the effect of storage on colour for *metkut*, an pulse based food adjunct.

Table. 4: Colour measurement using Lovibond Tintometer during ambient temperature storage for 90 days

Sample	**R/Y/B**	**0 day**	**15 day**	**30 day**	**45 day**	**60 day**	**75 day**	**90 day**
PET/PE	R	6.3	6.3	6.1	6.1	6.1	6.0	6.0
	Y	17.0	18.0	22.0	25.0	25.3	26.5	27.0
	B	5.1	5.1	5.1	5.3	5.6	5.7	6.1
PET/Met. Poly/PE	R	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	Y	17.0	17.0	17.0	17.2	17.4	19.4	23.0
	B	5.5	5.5	5.6	6.0	6.0	6.0	6.0

IV. CONCLUSION

Sandge, a traditional food adjunct in Indian cuisine was standardized and the components, carrot (80%), okra (9%), green chilies (3.5%), sesame seeds (3.5%), coriander leaves and salt (2%) each were found to be optimum. The prepared product was dried in a cabinet drier at 50ºC. It is nutritionally a good source of fiber, protein, vitamin C, carotene and iron. The product when packaged in metallized polyester/ polythene laminated pouches had a shelf life of more than 90 days at ambient temperature conditions. The traditional method of sun drying, although being economical, is highly dependent on climatic conditions, is time consuming and offers no protection against dust from air, rodents and insects. The tray/cabinet drying method is faster, yields a hygienic product of consistent quality and retains sufficient amount of nutrients. PET/Metallized polyester/ polythene packaging extended the shelf life of the product and was attractive. The traditional food adjuncts sector has been dominated by cottage/ small scale industries. Limited production capacity, technological input and quality assurance has lead to restricted growth of the industry. Standardization of processes, nutritional properties, optimum packaging and storage solutions can help in technological upgradation, quality assurance, consistent and uninterrupted supply of these products, higher turnover and global market for these products.

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