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Nutrient rich baked sev

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Abstract
A study was conducted to develop a nutrient rich snack product sev and to check its storage stability prepared by using multiple flours i.e., chickpea flour, rice flour, horsegram flour and spinach puree. Chickpea flour is used as key flour. It is rich in protein (23.63%). The main objective to incorporate rice flour is to provide crispiness and instant energy to the sev whereas horsegram flour is excellent source of protein (22.22%), iron (7.03mg/100g) and calcium (mg/100g). It also contains natural phenols, flavonoids and anti-oxidants. Also spinach puree increases iron content and it is rich source of iron (90mg/100g) and antioxidants (19.80%). As traditional deep fried sev contains high amount of oil which causes coronary heart diseases, obesity problems, etc. An innovation is brought by replacing deep frying with baking by keeping health as a major concern. With the help of above ingredients, protein (16.72%), calcium (211mg/100g) and iron (3.40mg/100g) rich sev was prepared which is significantly low in fat content (13.18%). This modified sev can be consumed by all age group people contributing to the eradication of the malnutrition problems because of its high nutritional value.

Keywords: Sev, chickpea flour, rice flour, horsegram flour, spinach puree, deep frying, baking

1. Introduction
Snack foods are playing a vital role in our day to day life. These are the items eaten for pleasure and during relaxation (Vinothini K, *et al*., 2015). Sev is one of the popular Indian snack food item. It is available in small pieces of crunchy noodles made from chickpea flour paste which is seasoned with turmeric and chilli powder and deep-fried in oil. These noodles vary in thickness. This popular snack being tasty and tempting is simultaneously full of fats as it is deep fried (Raut S. S. and Sengupta R., 2014) [21]. The high oil content is often not essential for product quality and is disadvantageous for both the food processor as well as the consumer. Hence, reducing oil content of these products is an area of interest to researcher (Priya et al., 1996).
As per 'The State of Food Insecurity in the World 2012', India remains home to the largest number of undernourished people in the world: 217 million (17.5% of its population) as of 2012. However, the status of hunger and malnutrition in India varies according different sources/estimates, and goes up to 67% to 77% (Gupta, 2016). Moreover, hunger and malnutrition have a distinct gender dimension and are widespread among women/ mothers. More than 70% women and kids have serious nutritional deficiencies (Fighting Hunger and Malnutrition- Survey Report, 2011) [12]. With growing concern of diet, weight control and general health, government bodies are recommending to the peoples and making a conscious effort to eat healthier, natural snacks such as fruit, vegetable, nuts and cereal grains while avoiding high-calorie, low-calorie nutrient junk food (Raut S. S. and Sengupta R., 2014) [21].
Legumes have been considered as a rich source of protein throughout the world and contain approximately three times more proteins than cereals. Chickpea (*Cicer arietinum* L.) is one of the top five important legumes based on whole grain production (FAO, 2000). It is an important component of the diets of those individuals who cannot afford animal proteins or those who are vegetarian by choice. It is also cholesterol free and a good source of dietary fibre, vitamins, minerals (Jukantil *et al*., 2012) [13]. Horsegram [*Macrotyloma uniflorum* (L.) Verdc] is an underutilized indigenous legume and one of the highly nutritious vegetable pulse crop with ethno-medicinal values in India, which is commonly known as Kulattha (Sanskrit) (Bhartiya *et al.*, 2015) [5]. Rice flour is a particularly good substitute for wheat flour, which causes irritation in the digestive systems of those who are gluten-intolerant (Chandra S. and Shamsher *et al*., 2013) [7]. It is also a good source of thiamine (vitamin B1), riboflavin (vitamin B2) and niacin (vitamin B3) Depa *et al.*, (2008). Spinach has a high nutritional value and is extremely rich in antioxidants. It also contains different carotenoids like lutein, ßcarotene, violaxanthin and 9'-(Z)-neoxanthin and has high concentration of vitamins like A, E, C, and K. They also possess folic acid and oxalic acid (Kavitha *et al*., 2013) [14]. In the light of above discussions, a study was carried out for the development of healthy snack product.

2. Materials and Methods

Ingredients used in the development of nutrient rich baked Sev were of good quality and free from contamination. All the ingredients were procured from the local market of Kolhapur. The main ingredients used were Chickpea flour, Rice flour, Horsegram flour, Spinach, Salt, Spices (Chilli powder, ajwain), Edible vegetable oil and Water. The main equipments used are an electronic weighing balance, sealing machine, soxhlet extractor and Hot air oven. The equipments used were from Department of technology laboratory Kolhapur.

2.1 Preparation of Spinach puree

- Fresh spinach leaves were collected from local market followed by sorting of leaves.
- They were washed properly and blanched.
- Blanched leaves were grinded using home scale grinder to form puree.

2.2 Preparation of control SEV

Control sample was prepared from soft dough of chickpea flour obtained by adding the requisite of water and fat, salt, chilli powder and ajwain at the rate of 3g, 3g, 0.5g, 0.5g respectively to 100g of flour and fried by extrusion through a hand operated extruder in to 300 ml of hydrogenated oil at 175 ± 5^0C for 45-50 seconds with turning after few seconds to ensure even frying.

2.3 Preparation of baked nutrient rich SEV

The steps used for the preparation of baked nutrient rich sev were discussed in Fig.1

Raw materials (Chickpea flour, rice flour and horsegram flour)
↓
Addition of spinach puree
↓
Heat oil for 2-3 minutes
↓
Blend with oil, salt, all spices and water
↓
Knead well to make dough
↓
Fill the dough in hand extruder
↓
Place the pressed sev on a greased baking tray
↓
Place the baking tray in a pre-heated oven at optimized temperature and time
↓
Baked sev
↓
Storage

Fig 1: Flow chart for the preparation of nutrient rich baked Sev

2.5 Incorporation and Optimization of raw materials in product

2.5.1 Preparation of control sample (control sev)

Table 1: Preparation of control sev

Ingredients	Chickpea flour	Salt	Chilli powder	Ajwain powder	Vegetable cooking oil
Quantity(g/100g flour mix)	100%	2%	1%	1%	3%

2.5.2 Preparation of nutrient rich baked sev

For the preparation of nutrient rich baked sev, chickpea flour was first optimized with rice flour. Among them best sample was selected for further optimization with horsegram flour on the basis of sensory evaluation and physical parameters of the sev. Further, the best sample amongst them was selected on the basis of sensory evaluation and further optimized with the spinach puree. Weight of remaining ingredients were kept constant throughout the optimization process. The final optimized formulation is as follows.

Table 2: Preparation of nutrient rich baked sev

Sample Code	Chickpea flour	Rice flour	Horsegram flour	Spinach puree
NRBS0	55	30	15	00
NRBS1	55	30	15	10
NRBS2	55	30	15	15
NRBS3	55	30	15	20

2.5.3 Optimization of the process for preparation of nutrient rich baked sev

Table 3: Optimization for the process of nutrient rich baked sev

Temperature (ºC)	Time (minutes)	Temperature (ºC)	Time (minutes)
120	20	150	20
	25		25
	30		30
130	20	160	20
	25		25
	30		30
140	20	170	20
	25		25
	30		30

2.6 Physicochemical analysis of Raw materials

Chickpea flour, rice flour, horsegram flour and spinach puree.

2.6.1 Physical analysis

The analytical equipments included are Digital model of Vernier caliper for thickness, length, Width, an electronic balance with the accuracy of 0.0001g for weight measurements, spectrophotometer (model UV-2800) for estimation of total phenolic compound, antioxidant activity. Texture analysis is done by texturizer (Hunter color lab at ICT Mumbai).

2.6.2 Chemical analysis

Chemical Analysis includes Moisture, Ash, Fat, Crude fibre, Carbohydrates and Protein were estimated by standard methods (AOAC, 2000) [1]. Mineral contents such as calcium, iron and potassium were analyzed by method described by (Gopalan, *et al.*, 1999) [10].

2.6.3 Functional properties

Functional properties of flour like water and oil absorption capacity (WAC and OAC), Foaming capacity (FC) and foam stability (FS), and Bulk density (BD) (Narayana and Narasinga Rao, 1982) were analysed.

2.7 Sensory evaluation of sev

Samples were subjected to organoleptic testing before and after the storage. Organoleptic analysis were carried out in order to determine the various factors like overall acceptability, taste, flavour, colour, aroma etc., and their changes with the number of storage days and parameters. Sensory attributes including appearance, flavour, texture, taste and overall acceptability of the product were evaluated by Hedonic Rating Test as recommended by Ranganna (1986).

2.8 Storage study of prepared nutrient rich baked sev

The prepared nutrient rich baked sev were packed in PP (Polypropylene), LDPE (Low density polyethylene) and (AL) Aluminum laminate bags and stored at room temperature for the period of three months. The moisture content and peroxide value were analyzed as well as sensory and microbial analysis was done at the regular interval of 15 days throughout the storage period.

Results and Discussion

Table 4: Physico-chemical components of raw materials

Components	Chickpea flour	Rice Flour	Horsegram flour	Spinach leaves
Moisture (%)	2.074 ± 0.23	11.930± 0.06	6.234 ± 0.24	90.27 ± 0.59
Total Ash (%)	2.163 ± 0.02	0.369 ± 0.03	2.683 ± 0.00	1.685 ± 0.01
Protein (%)	23.63 ± 0.25	6.2 ± 0.10	22.22 ± 0.34	1.91 ± 0.08
Fat (%)	4.734 ± 0.04	1.497 ± 0.23	1.380 ± 0.00	0.53 ± 0.18
Carbohydrate	57.489 ± 1.01	0.56 ± 1.02	62.253 ± 0.01	5.005 ± 0.00
Crude fibre (%)	9.91 ± 0.34	0.56 ± 1.02	5.23 ± 0.15	0.6 ± 0.02
Iron (mg/100g)	4.59	2.70	7.03	90.00
Calcium content (mg/100gm)	45	10	290	99

Data are expressed as mean ± standard deviation of triplicate experiments (n=3)

Table 5: Total phenolic content, antioxidant activity of spinach leaves

Components	Spinach leaves
TPC (GAE mg/g)	46.07
Antioxidant activity (%RSA)	19.80

Table 6: Functional properties of flours used for preparation of nutrient rich sev

Materials\Parameters	Chickpea flour	Rice flour	Horsegram flour
Bulk density (gm/cm3)	0.459±0.04	0.811±0.00	1.53±0.01
Water absorption capacity (%)	130.9±60	121±20.98	140.14±0.78
Oil absorption capacity (%)	108.8±1.30	123±21.90	82.00±30
Foam capacity (%)	45.3±2.10	3.78±0.86	37.89±1.01
Foam stability (%)	40.01±1.70	0.97±0.00	35.00±0.07

Data are expressed as mean ± standard deviation of triplicate experiments (n=3)

Table 7: Physico-chemical analysis of control sev and prepared nutrient rich sev prepared by baking

Parameters	Control Sev	Baked sev	Parameters	Control Sev	Baked sev
Moisture (%)	5.40±0.01	5.80±0.15	Calcium (mg/100g)	191.68±0.36	211.30±0.23
Protein (%)	15.95±0.10	16.72±0.06	Potassium (mg/100g)	218.35±0.18	180.60±0.30
Fat (%)	30.17±0.01	13.18±0.18	Energy (Kcals)	521.65±0.01	433.02±0.01
Total Ash (%)	1.10±0.04	0.90±0.10	Peroxide (meq/kg)	0.44±0.01	0.33±0.15
Carbohydrate (%)	46.58±1.00	61.88±0.16	Thickness (mm)	1.2±0.01	1.2±0.06
Crude fibre (%)	0.55±0.01	0.85±0.003	Hardness (gm)	1667±0.11	240±0.02
Iron (mg/100g)	2.00±0.50	3.40±0.007			

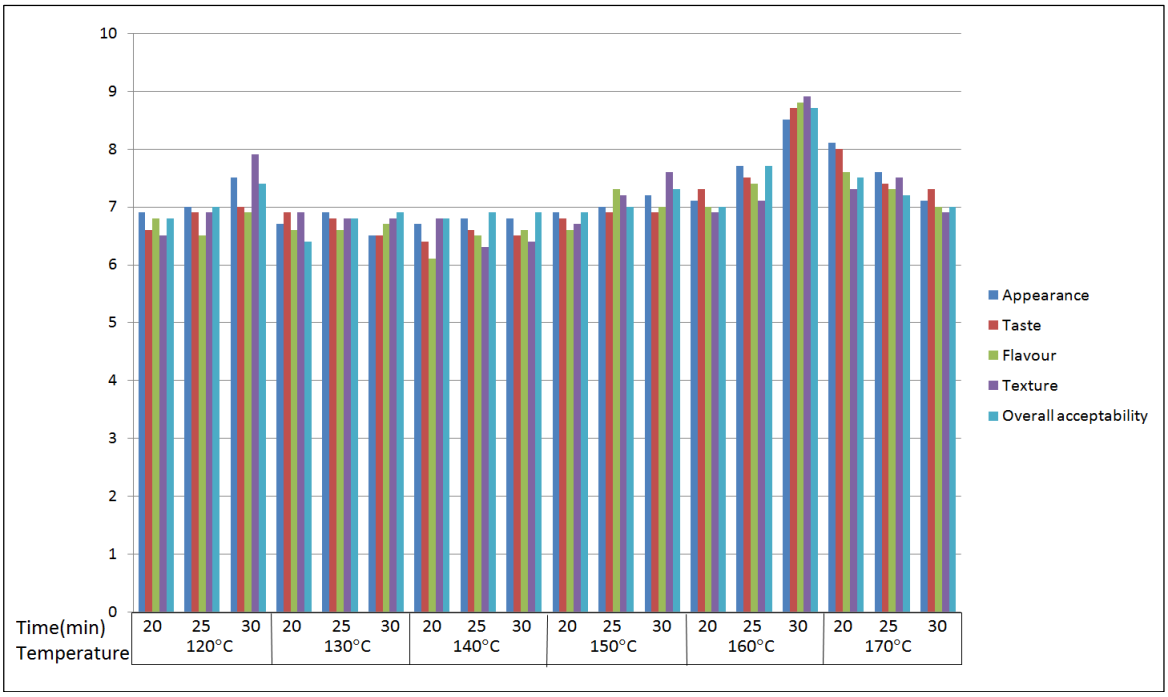

Fig 2: Sensory evaluation of optimization process of nutrient rich baked sev

In the resulted product protein content is increased from 15.95% to 17.72%, carbohydrate content is increased from 46.58% to 61.88%, iron content is increased from 2.00mg/100gm to 3.40mg/100gm, calcium content is increased from 191.68mg/100gm to 211.20mg/100gm while fat content is significantly decreased from 30.17% to 13.18% than the control sev which comprises of only chickpea flour.

Sensory evaluation of optimization process of nutrient rich baked sev was done for the attributes namely appearance, taste, flavour, texture and overall acceptability as shown in the graph (Figure 2) given above. It was found that sample baked at 160^0C for 30 minutes was best as per the sensory evaluation.

Table 8: Storage study of nutrient rich baked sev at room temperature.

Storage period (Days)	PP			LDPE			AL		
	Moisture (%)	Peroxide value (meq/kg)	TPC (cfu/g)	Moisture (%)	Peroxide value (meq/kg)	TPC (cfu/g)	Moisture (%)	Peroxide value (meq/kg)	TPC (cfu/g)
0	5.80	0.33	ND	5.80	0.33	ND	5.80	0.33	ND
15	5.84	1.21	ND	5.82	1.14	ND	5.82	1.08	ND
30	5.86	2.42	ND	5.85	2.25	ND	5.84	2.30	ND
45	5.89	3.61	ND	5.87	3.35	ND	5.86	3.24	ND
60	5.92	5.81	ND	5.91	4.71	ND	5.90	3.86	ND
75	5.96	6.23	ND	5.95	5.65	ND	5.94	5.03	ND
90	6.01	6.78	5.7×10^2	5.99	5.93	4.6×10^2	5.98	5.77	2.8×10^2

ND- Not detected

The results of storage study of moisture content, peroxide value and total plate count of all samples have been presented in the table no.8 given below. It was concluded that incorporation of spinach puree affected the moisture content of snack food samples. The increase in moisture content of snack food samples was slow. It was also concluded that packaging material also affected the moisture content of snack food sample. Since, Aluminium laminates has low oxygen transmission rate as compared to LDPE and PP peroxidation takes place slowly in aluminum laminate as compared to LDPE and PP. It was also observed that there was no bacterial count upto 75 days of storage.

Table 9: Storage study of nutrient rich baked sev at room temperature

Storage period (Days)	PP				LDPE				AL			
	Taste	Flavor	Texture	O.A.	Taste	Flavor	Texture	O.A.	Taste	Flavor	Texture	O.A.
0	8.6	8.4	7.9	8.7	8.4	8.6	7.9	8.7	8.4	8.6	7.8	8.7
15	8.4	8.3	7.8	8.5	8.2	8.3	7.8	8.6	8.5	8.9	7.9	8.8
30	8.0	8.1	7.4	8.1	8.0	8.0	7.7	8.2	8.1	8.3	7.6	8.9
45	7.9	7.8	7.0	7.9	7.9	7.8	7.3	7.8	8.0	7.9	7.3	8.4
60	7.6	7.6	6.9	7.7	7.5	7.5	6.9	7.5	7.8	7.6	7.1	7.8
75	7.3	6.7	6.6	7.1	7.1	7.0	6.6	7.6	7.4	7.8	6.6	7.6
90	6.8	6.3	6.1	6.9	7.0	6.8	6.4	6.8	6.9	6.9	6.5	7.3

It was also observed from sensory evaluation table no.9, which is shown below that flavour, texture, and overall acceptability of nutrient rich baked sev was excellent, while after 75 days of storage the flavour was satisfactory. Texture is seen as significant attribute of snack food product. It was observed that there is slightly decreasing trend in texture score throughout the storage period. Although the nutrient rich baked sev packed in aluminum laminates got more score and overall acceptability followed by nutrient rich baked sev packed in LDPE and PP.

Conclusion

The goal of this study was to make nutrient rich sev as well as reducing the fat content. Thus, an underutilized legume i.e., horsegram flour, rice flour and spinach was incorporated in sev which increased the protein (16.72%), calcium (211.30 mg/100g) and iron (3.40mg/100g) content of the sev. Baking method was optimized which showed significant decrease in fat content (13.18%) as compared to the control sample (30.17%). Baked sev prepared exhibited a more suitable nutritional and sensory profile than control sev sample. To conduct study on ambient storage behavior, snack food sample was packed in three different packaging material viz. polypropylene, low density polyethylene and aluminium laminate. Among which aluminium laminate was found to be most suitable packaging material to maintain the sensory attributes and microbiological quality of prepared baked sev upto 90 days. Thus, nutrient rich baked sev can be consumed by all age group people and it will help in improving the health of consumers and also can serve as good supplement.

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