Development of ready-to-fry frozen vegetable snack and its quality evaluation

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Revised: 4 March 2010 / Accepted: 22 April 2010 / Published online: 12 February 2011
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Abstract A formulation for the development of a crispy texture of crust in vegetable snack after freezing and frying was standardized using different flours such as whole-wheat flour (WWF), refined wheat flour (RWF), rice flour (RF) and semolina (S). Formulation with 60% WWF, 20% RWF, 10% RF and 10% S was selected based on sensory characteristics (overall acceptability >7.8). Incorporation of RF significantly ($P<0.05$) changed the texture of the raw snack as indicated by texture profile analysis. Higher levels of rice flour resulted in whitish color in raw as well as fried snacks. However, the cooking time was more in the snacks fried directly from the frozen state (6.18 min) than the frozen-thawed fried snack (4.35 min). Quality of the snacks in terms of color values, appearance and texture was found to be superior to the thawed fried snack. During frozen storage of 16 months at -20 ± 1 °C, the overall acceptability (OAA) and lightness was found to be decreased from the original value. Rancidity parameters in terms of free fatty acids, peroxide value and thiobarbituric acid showed a restricted rise with the progression of storage period. The developed frozen snack was found to be microbiologically safe during the storage period.

Keywords Freezing · Vegetable snack · Rice flour · Sensory · Texture · Color · Frozen storage

Introduction

The demand for ready-to-eat convenient food items is rising due to changing lifestyle. To cater the need, a range of frozen food products is being introduced in the market continually. The major reasons for enhanced use and range of frozen foods are increased desire for convenience in terms of time required for food preparation, decreasing family size, increased levels of disposable income, wider travel abroad and adaptability of consumers towards of different cuisines. Snack foods have emerged as one of the main entries in the food market that can be adapted to consumer needs. However, maintenance of quality of this product is of key importance to the continued development of this sector. Quality and safety of frozen snack food are the aspects affecting the overall consumer acceptability in terms of flavor, texture, aroma, color and appearance besides microbiological safety and nutritional quality (Torres and Canet 2001).

Frozen foods upon freezing are thawed and reheated before consumption. Conventional thawing is achieved by storing frozen foods in defrosting rooms at refrigerated temperature (Bialod et al. 1978). When frozen food is thawed, the ice-crystals melts resulting in the absorption of liquid back into the food or leaking it out from the food and it causes softening of texture and deterioration of overall quality (Goodenough and Atkin 1981; Rahman 1999). Slow thawing usually results in better retention of moisture in the food. However food quality deteriorates due to enhanced period for growth and activity of microorganisms. Generally, frozen ready-to-eat snack food is consumed with no or little further processing except reheating. These frozen vegetable snacks can directly be fried in oil without thawing after frozen storage (Creed 2006).

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The constituents of the dough used for the preparation of casing of snacks affect certain quality attributes significantly. Moisture, protein content, amylose and amylopectin components were reported to affect the physical quality parameters such as elasticity, linear expansion, oil absorption and crunchiness of fried products (Mohamed et al. 1989). Formulations of various non-vegetable frozen snacks such as soy beef patties (Berry 1990), soy-carrageenan beef patties (Brewer et al. 1992), skipjack tuna patties (Iwaoka and Akamine 1993), irradiated beef patties (Luchsinger et al. 1997) are reported in the literature. However, no reports are available for the preparation of frozen vegetable snacks with vegetable stuffing and flour based outer casing. During the preparation of snack dough, whole-wheat flour, refined wheat flour were used as the basic dough forming materials due to their elastic properties of gluten to expand and impart a spongy texture for passage of moisture and oil during frying (Mukprasirt et al. 2001).

In our earlier work, the kinetics of texture development during frying of vegetable stuffed snacks subjected to different initial conditions such as frozen, frozen-thawed, and unfrozen (Maity et al. 2009) were reported. However effect of different flour formulations on the overall quality of fried snacks needs to be investigated. Hence, a study was made to evaluate the effect of different flour formulations of whole-wheat flour, refined wheat flour, rice flour and semolina used for the formation of outer casing of vegetable-based snacks on the sensory, instrumental texture and other quality attributes of the fried snacks. Selected snack was evaluated for storage stability in terms of rancidity parameters such as thiobarbituric acid, free fatty acid, and peroxide value. Change in organoleptic characteristics was also evaluated during storage.

Materials and methods

Preparation of the snack

Raw materials for the preparation of vegetable snack such as whole-wheat flour (WWF), refined wheat flour (RWF), rice flour (RF), semolina, vegetables (potato and carrot) and sunflower oil were purchased from the local super market of Mysore. All the three flours were roasted for 2 min. at 150 °C and stored at 6 °C until further processing. Vegetables were surface sanitized with chlorinated water (50 ppm) before grating. Vegetables were grated manually in a hand-operated grater into 18–20 mm long and 3 mm thick shreds. Grated material was blanched (85 °C; 3 min.) and sautéed in sunflower oil in 1:10 ratio (w/v) to golden brown color. Based on preliminary sensory trials recipe for stuffing was standardized. Formulation of vegetable stuffing included vegetables and cheese (2:1), 2% butter, 1.5%

salt, 10% condiment paste (onion:garlic:ginger::2:1:1) and 1.5% dried and powdered spice mix. Ingredients of the spice mix were coriander (2 parts), red chilly (1 part), turmeric (1 part), cumin (1 part), cinnamon (0.2 parts), black pepper (0.2 parts), cardamom (0.2 parts), mace and clove (0.2 parts). For the standardization of the casing of the vegetable snack different formulations of flours used for making the snack casing were F₁: 60% WWF, 20% RWF, 15% RF and 5% semolina; F₂: 60% WWF, 20% RWF, 10% RF and 10% semolina; F₃: 60% WWF, 20% RWF, 5% RF and 15% semolina. The dough was kneaded with equal quantities of water and milk (60% of the flour weight). The formulations were based on previous trials conducted in the laboratory to get crispy texture in the final fried snack. Casing was prepared by pressing 25 g dough into a sheet (0.3 mm thickness) and vegetable stuffing (30 g) was filled into it. The edges were sealed in such a way that the vegetable stuffing could not drop. The snacks (6×4×2.5 cm) were then packed and sealed in 7×7 inches polyethylene (PE) pouches of 100 µ. Various processing steps in the preparation of vegetable snacks are outlined in Fig. 1. PE bags containing un-fried snack samples were frozen at –40 °C for 3 hours at an air velocity of 8 m s^{–1} in a blast freezer (M/s Cryoscientific, Chennai) equipped with freezing rate controller. Subsequently the frozen samples were stored in deep freezer at –20 °C until the frying trials.

Frying of snacks

Snacks were deep fat fried from the frozen and frozen-thawed states immediately after freezing and at an interval of 2 months

Fig. 1 Flow-chart for the preparation of the snack

up to the end of the storage period in a laboratory scale deep fat fryer (M/s Continental Equipment Ltd, Bangalore, India) with temperature controller to control within ± 2 °C. The fryer was equipped with a stainless steel (SS) wire basket in which sample was placed. Prior to frying, sunflower oil (3:1, v/w) was preheated to 150 °C. Frozen snack was fried on one side (2 min.), and then turned on the other (2 min.) while with frozen-thawed snack turning was done at 1 min. interval until cooking was completed. The temperature was monitored using a digital thermometer with J type thermocouple probe of 1.6 mm diameter (M/s Spectrochem Pvt. Ltd, Mumbai, India). After frying, the samples were drained (20 s) and gently wiped with adsorbent paper to remove surface oil. The experiment was replicated three times.

Quality analyses of the snack

Sensory evaluation

The sensory evaluation of the final fried snack samples was carried out in terms of appearance, taste, flavor, texture and overall acceptability using a nine point Hedonic scale according to Larmond (1977) by semi-trained panel consisting of twenty members. Panelists were scientific staffs of the laboratory who were trained in attributing rating for the characteristics examined. The scores were assigned from extremely liked (9) to disliked extremely (1). Samples were served in plates labeled with a random number under white light at 25 °C.

Drip loss and cooking loss

The snacks were removed from the packages after thawing for 1 h at room temperature, blotted on paper and weighed to determine the drip loss. Cooking loss was determined by measuring the weight difference between the pre-fried and fried snacks.

CIE color values

The tristimulus color values L^* (lightness), a^* (redness) and b^* (yellowness) values of surface of samples (raw and fried snacks) were recorded on CIE scale in triplicate using a colorimeter (M/s Miniscan XE plus, Model No. 45/0-S, Hunter Associates Laboratory, Inc., Reston, VA, USA) which was earlier calibrated using white and black standard ceramic tiles. The observations were made using D-65 illuminant and 10° observer.

Texture profile analysis

Texture profile analysis of frozen and thawed snacks were performed by determining the hardness, fracturability, gum-

miness and cohesiveness using a texture analyzer (M/s TAHDi, Stable Microsystems, London, UK) loaded with Texture Expert Software (Version 1.22; Stable Microsystems, London, UK). The software automatically calculated the textural parameters as follows: hardness (N) is given either as the first force peak when there are two peaks on the chart or by the second peak if there are three peaks. Adhesiveness (Ns) is the negative area between the point at which the first curve reached a zero force value after the first compression and the start of the second curve. Springiness (mm) was calculated as the ratio of the distance or time from the start of the second area up to the second probe reversal vs. the distance or time between the start of the first area and the first probe reversal. Cohesiveness is the extent to which a material can be deformed before it ruptures. It was calculated as the ratio (dimensionless) of the positive force area during the second compression portion to the positive area during the first compression. Chewiness (N) was calculated as the product of hardness, cohesiveness and springiness. Firmness was measured by cutting the thawed snack in the center with a Warner Bratzler blade operated at a test speed of 0.5 mm s^{-1} . The pre and post speeds were set at 1 mm s^{-1} and 5 mm s^{-1} ; respectively.

Chemical analysis

During storage, the quality was monitored by studying the changes in peroxide value (PV), free fatty acids (FFA) as per AOAC (1990) while thiobarbituric acid (TBA) value was determined using the method reported by Tarladgis et al. (1960).

Microbiological analysis

The microbiological analyses in terms of standard plate count, yeasts and molds count and psychotropic counts were carried out using standard methodology (APHA 1992) at zero time and then at a regular interval of two months.

Statistical analyses

All the measurements in this study were made in three replications. Statistical analysis was performed by analysis of variance (ANOVA) to calculate critical difference of the data to statistically predict the significance. Significance was established at $P < 0.05$ level.

Results and discussion

Standardization of crust ingredients is highly important for obtaining proper texture for the crust of the vegetable snack and the crust quality also influences the stuffing holdness of

Table 1 Effect of different flour combinations on sensory parameters of frozen vegetable snack casing after frying ($n=20$)

Formulations	Appearance	Taste	Aroma	Texture	OAA
F ₁	7.67±0.05 ^a	7.51±0.06 ^b	7.78±0.04 ^a	7.34±0.08 ^c	7.51±0.06 ^c
F ₂	7.87±0.08 ^a	7.93±0.05 ^a	7.90±0.06 ^a	7.83±0.04 ^a	7.86±0.04 ^a
F ₃	7.78±0.11 ^a	7.54±0.04 ^b	7.76±0.05 ^a	7.51±0.05 ^b	7.69±0.03 ^b

Values with different superscripts in the same column differ significantly ($P<0.05$). F₁: 60% WWF, 20% RWF, 15% RF, 5% S; F₂: 60% WWF, 20% RWF, 10% RF, 10% S; F₃: 60% WWF, 20% RWF, 5% RF, 15% S.

the snack. Improper crust formulations tend to harden the crust or yield a soggy texture. Improper formulations also tend to weaken the crust resulting in opening of the snack during freezing and frying. Three formulations of flours namely F₁, F₂ and F₃ as mentioned in the earlier section were used to make the snack casing and evaluated for sensory acceptance.

Standardization of the snack casing

Freezing is a process, which causes loosening of texture in the food products. In the current study, snack casing prepared only with wheat flour was observed with a soggy and mushy product after freezing and thawing. Therefore, effect of incorporation of different flours and there combinations were evaluated to minimize the freezing effect on snack casing and to improve the crispy texture in the final fried snack. Table 1 shows the results for the sensory evaluation of the snacks prepared from different formulations of WWF, RWF, RF and semolina. The proportions of WWF and RWF were kept constant in all the flour formulations. Data recorded from the sensory quality of different formulations of snack casing indicated that the formulation F₂ containing 60% WWF, 20% RWF, 10% RF and 10% semolina recorded the highest overall acceptability (OAA) score (7.86). It differed significantly ($P<0.05$) with the organoleptic scores of formulation F₁ and F₃. Taste and texture also improved significantly ($P<0.05$) in the samples prepared from F₂ formulation. However, there was statistically insignificant ($P>0.05$) difference between all the three types of snacks in terms of aroma and appearance. Incorporation of semolina and rice flour at the rate of 10% resulted in crispier texture in the final product. However, formulations containing less proportion of rice flour and high proportion of semolina or vice versa did not resulted in the desired acceptability of the fried snacks. Mohamed et al. (1998) also reported that addition of pre-gelatinized rice flour imparted higher crispness in fried products. Our results suggested that a balanced amount of RF and semolina is required to produce the desirable texture in the snack. The standardized snack (F₂) was evaluated for storage stability.

Frying of frozen and frozen-thawed snacks

In the present study, the snacks standardized based on sensory acceptability (F₂) were selected to compare the effect of direct frying of snacks of frozen state to frozen-thawed state. Snacks cooked from the thawed condition have substantially shorter cooking times (4 min 35 sec) than frozen state (6 min 18 sec). To compare the quality parameters such as drip loss, cooking yield, surface color values; a uniform average frying time of 5 min & 26 sec was used for the frying of both frozen and frozen-thawed snacks. Visual brown color was quickly achieved in snacks fried after 1 hour of thawing in contrast to those fried directly from frozen state. The inside core was well cooked with better visual appearance (golden-brown) in frozen-fried samples. Thawing prior to frying produced darkness in the snack for the same frying time which was indicated by lower L* value (Table 2). The difference in the crust color of the snacks may be due to the initial conditions of the snacks and rate of heat transfer in the snacks during frying. The cooking yield in frozen-fried snack samples was found to be lower as compared to the frozen-thawed fried snacks. However, the difference was not significant ($P>0.05$). The difference in yield could be accredited to occurrence of drip loss (8%). Our results are in agreement with the results of Van Laack et al. (1996) and Berry (1997) who also reported decrease in cooking time and increase in cooking yield with direct cooking from frozen state over the frozen-thawed condition in case of beef patties. Direct frying of the frozen snacks was found beneficial in

Table 2 Quality attributes of the snacks (F₂) fried in frozen and frozen-thawed state

Parameters	Frozen	Frozen thawed
Cooking time (minute: second)	6:18	4:35
Drip loss (%)	—	8.12
Cooking yield (%)	86.82	90.64
CIE L*	47.98±0.03	43.21±0.02
CIE a*	5.29±0.08	6.35±0.03
CIE b*	25.98±0.03	28.62±0.04

Table 3 Effect of different flour formulations on CIE color values of frozen snack casing ($n=3$)

Formulations	L*		a*		b*	
	Before frying	After frying	Before frying	After frying	Before frying	After frying
F ₁	66.66±0.07 ^a	51.62±0.12 ^b	2.3±0.07 ^c	4.83±0.05 ^b	18.67±0.06 ^c	23.27±0.05 ^b
F ₂	65.41±0.06 ^a	47.98±0.03 ^c	2.01±0.07 ^c	5.29±0.08 ^{ab}	19.11±0.04 ^c	25.98±0.03 ^{ab}
F ₃	64.45±0.08 ^a	44.29±0.04 ^c	1.71±0.02 ^d	6.02±0.04 ^a	19.71±0.02 ^c	28.16±0.07 ^a

Values with different superscripts in the same column differ significantly ($P<0.05$). F₁: 60% WWF, 20% RWF, 15% RF, 5% S; F₂: 60% WWF, 20% RWF, 10% RF, 10% S; F₃: 60% WWF, 20% RWF, 5% RF, 15% S

minimizing the processing time with better quality of the final product.

Effect of different formulations on CIE color values

Colour could be considered as an important attribute, which significantly affects the consumer's perception as well as determines the nutritional quality of food products during storage (Patras et al. 2009). Color development in fried products is the result of maillard browning. The fried snacks were found to have lower L* value than the raw snacks for all the formulations. However, the a* and b* values increased in all the samples after frying (Table 3). Improvement in casing color has been found by increasing the% of RF in the raw snack as well as the final fried product. Snacks casing prepared from the formulation containing 15% RF showed maximum lightness in the raw (66.66) and fried snack (50.62). Color a* was found to be decreased by increasing level of semolina with associated decrease in RF content while the b* value increased. It is interesting to note that the increase in a* value after frying was much higher in the snack prepared from a formulation containing less percentage of RF (F₃) than those containing higher amount of the same. Snacks prepared from formulation F₃ appeared darker in color due to decrease in L* value and increase in a* and b* values, while the snacks prepared from the formulation F₂ were light brown in color. The CIE L*, a* and b* values of the snack prepared from flour combination F₂ could be used to judge the acceptability of the product.

Effect of different formulations on textural parameters of the snack

Table 4 shows the results for the texture profile analysis of the raw snacks in terms of hardness, fracturability, adhesiveness, springiness, cohesiveness and chewiness. Results suggested that decrease in the level of RF with increase in the level of semolina led to softening of the snacks. However, fracturability and cohesiveness did not show any regular trends which may be due to heterogeneous ingredients used in the stuffing. The adhesiveness was found to be higher in the snacks prepared from formulation F₁ containing higher proportion of RF. This may be due to the sticky nature of amylopectin present in rice flour. The decrease in springiness and chewiness with decrease in RF proportion in the formulation may be due to inherent granular structure and different physico-chemical properties of the rice starch during the dough kneading process than wheat starch. Reduction in rice flour content might have decreased the volume of the snack causing decrease in chewiness as rice starch is more porous and has more swelling power than wheat starch, which reflects increase in volume (Oyi et al. 2009).

Shelf stability

Based on sensory acceptance vegetable stuffed snack made from formulation F₂ was kept for storage and evaluated for shelf stability. The lightness of the surface of the raw snack decreased with the progress of storage period (−20 °C) as indicated by decrease in CIE L* value in Table 5. With the

Table 4 Effect of different flour combinations on textural parameters of Frozen vegetable snack casing after frying ($n=3$)

Formulations	Hardness (N)	Fracturability (N)	Adhesiveness (Ns)	Springiness (mm)	Cohesiveness	Chewiness (N)
F ₁	48.79±0.19 ^a	0.117±0.004 ^b	43.85±0.57 ^a	0.220±0.002 ^a	0.241±0.007 ^b	2.59±0.09 ^a
F ₂	47.90±0.06 ^{ab}	0.108±0.003 ^c	37.43±0.43 ^b	0.209±0.003 ^a	0.258±0.006 ^a	2.40±0.01 ^a
F ₃	46.02±0.03 ^b	0.145±0.004 ^a	28.74±0.46 ^c	0.157±0.001 ^b	0.225±0.001 ^c	1.85±0.05 ^b

Values with different superscripts in the same column differ significantly ($P<0.05$). F₁: 60% WWF, 20% RWF, 15% RF, 5% S; F₂: 60% WWF, 20% RWF, 10% RF, 10% S; F₃: 60% WWF, 20% RWF, 5% RF, 15% S

Table 5 Changes in organoleptic properties (after frying) and CIE L* value of the selected vegetable snack (F₂) (un-fried) during storage at -20 °C

Sensory Parameters	Storage period (months)								
	0	2	4	6	8	10	12	14	16
Appearance	7.96±0.05 ^a	7.911±0.14 ^a	7.84±0.04 ^a	7.76±0.04 ^a	7.72±0.04 ^a	7.56±0.01 ^b	7.60±0.03 ^b	7.54±0.06 ^{bc}	7.28±0.04 ^c
Taste	7.93±0.02 ^a	7.89±0.15 ^a	7.85±0.05 ^a	7.81±0.09 ^a	7.77±0.03 ^a	7.63±0.01 ^{ab}	7.69±0.02 ^b	7.65±0.05 ^b	7.41±0.03 ^c
Aroma	7.94±0.03 ^a	7.91±0.09 ^a	7.86±0.02 ^a	7.82±0.05 ^a	7.78±0.07 ^{ab}	7.74±0.02 ^b	7.70±0.02 ^b	7.46±0.03 ^c	7.02±0.03 ^c
Texture	7.93±0.07 ^a	7.9±0.05 ^a	7.87±0.13 ^a	7.84±0.05 ^a	7.71±0.06 ^{ab}	7.68±0.04 ^b	7.56±0.03 ^b	7.22±0.02 ^{bc}	7.19±0.02 ^c
OAA	7.92±0.02 ^a	7.89±0.03 ^a	7.86±0.04 ^a	7.83±0.02 ^a	7.81±0.04 ^a	7.67±0.02 ^b	7.64±0.02 ^b	7.31±0.01 ^c	7.08±0.03 ^d
CIE L* value	65.43±0.02 ^a	65.31±0.02 ^a	65.22±0.02 ^a	65.14±0.03 ^a	65.03±0.04 ^{ab}	64.94±0.01 ^b	64.17±0.02 ^b	62.96±0.03 ^c	58.43±0.04 ^d

Values with different superscripts in the same row differ significantly. ($P<0.05$)

Fig. 2 Graphs showing the changes in rancidity parameters (FFA, PV and TBA) of the snack (F₂) during storage at -20 °C

progression of storage period, the snack surface color darkened which may be due to the surface moisture desiccation during frozen storage. Many authors have reported surface darkening of many bakery products due to prolonged frozen storage (Yi and Kerr 2009; Giannou and Tzia 2007). No significant ($P>0.05$) differences in L* value were observed up to 6 months of frozen storage. However, the decrease in L* value was found to be faster at the end of the storage. All the sensory attribute i.e. appearance, taste, aroma, texture and OAA of the frozen snack decreased

during the storage (Table 5). The OAA decreased significantly ($P < 0.05$) upon storage and was found to be still acceptable after 8 months of storage. However, Smith et al. (1985) reported appearance and sensory scores unaffected on storage at $-18\text{ }^{\circ}\text{C}$ up to 12 months in case of beef patties. However, Ho et al. (1995) reported a significant decrease in flavor score of frozen pork sausages just after 2 months frozen storage. The decrease in the sensory scores during storage may be attributed to the physico-chemical changes, which continue to occur even at frozen storage.

Percentage FFA, TBA and PV are the rancidity parameters indicating the oxidation of fat during storage of food products resulted in off flavor. The percentage FFA content of the snack increased during storage. The increase was recorded to be faster during initial period of frozen storage (up to 6 months) which came down after 6 months and further at a slower rate up to the end of storage period (16 months) (Fig 2a). Figure 2b represents the increase in PV of the snacks during the frozen storage. PV increased from an initial value of 0.680 to 0.725 Meq. O_2/Kg fat and it was found to be more pronounced after 10th months of storage. The initial TBA value of the snack was found to be 0.0273 mg Mal/kg snack. The increase in TBA value was slow and gradual up to 8 months of storage (Fig. 2c) and after 8 months, the increase was found to be not significant ($P > 0.05$) up to 14 months of storage. Increase in TBA value was also reported to be increased significantly after 8 weeks in ground beef patties during frozen storage (Brewer et al. 1992). Berry (1990) reported TBA values of 2.5 and 4.4 in ground beef patties made with/without soy after a frozen storage of 18 months. The change in FFA content, PV and TBA value during the entire frozen storage from the initial values was very less i.e. 3.2, 6.6 and 5.1%, respectively, which might be due to low temperature ($-20\text{ }^{\circ}\text{C}$) of the storage at which rate of chemical reactions ceases down.

Standard plate count and Yeast and mold count in the snacks were not prominent over the entire period of frozen storage. However, the psychrophiles such as aeromonas and pseudomonas were detected at the end of 16 months to the extent of 1.3 log CFU g^{-1} . Liu et al. (1991) reported a significant increase in coliform, aerobic and psychrotrophic plate counts from 2.96 to 4.74, 5.11 to 7.29 and 5.89 to 7.64 log CFU g^{-1} during storage ($-4\text{ }^{\circ}\text{C}$) of lean ground beef patties. Berry (1990) found 5.6 and 6.1 log CFU g^{-1} aerobic plate count in beef patties and soy extended beef patties, respectively after 6 months of frozen storage ($-23\text{ }^{\circ}\text{C}$). The microbial counts reported in all these products were higher which may be due to the different raw material used for the preparation of patties.

Conclusions

Crust crispness is a critical parameter in a consumer's evaluation of a particular fried food product. Incorporation

of rice flour and semolina in equal proportion resulted in acceptable crispy texture of the snack. The effect of these flours was also significant ($P < 0.05$) on color and other quality attributes. The studied quality characteristics such as snack surface color and overall acceptability underwent substantial decline during the frozen storage. Effect of frozen storage on quality of snacks was gradual in terms of changes in TBA, FFA and PV while microbiological counts for the snacks were negligible. The developed ready-to-fry frozen vegetable snack can provide convenience to the consumers by restricting the kitchen drudgery and time involved in the preparation of the snack.

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