Chapter 5

SUMMARY AND CONCLUSION

The present study “Development, characterization and storage behaviour of fibre rich extruded snack food” was carried out in three phases with an overall objective to develop an extruded snack food which would be organoleptically fit for consumption and marketable.

The fibre rich extruded snack food was developed as per the optimized conditions as rice to pomace and pulse ratio was 83.5:16.5, pulse and pomace ratio was 1:1 and the moisture content 19.23%, screw speed 310 rpm and temperature 110°C. The extrudates so obtained were packaged in metallized polypropylene. The extrudates were analysed to understand the changes in structure, colour and hardness. During storage, remarkable changes were observed in structural orientation of the fibre and cellular components of the unfried, fried and seasoned extruded snack food.

The photomicrograph revealed the presence of relatively much compact and dense structural orientation with numerous globules after six months of storage which may have lead to the increase in the hardness of the extrudates and may be the cause for the loss of crispiness of the extrudates. The microstructural, colour and textural properties of unfried, fried and seasoned extrudates changed during storage of six months and least changes in hardness and crispiness occurred in seasoned extrudates.

The changes in microstructure correlated with the variations in textural attributes like hardness and crispiness. The study revealed profound change in the structural orientation of the fibre and cellular components of the extrudates during storage in the unfried extruded

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snack foods. Similar pattern was observed in case of fried and seasoned extruded snack foods during the storage period.

Hardness of the extrudates was increased for unfried, fried and seasoned extrudates respectively during storage, consequently a decrease in crispiness was observed. The maximum hardness was observed for unfried extrudates, however maximum crunchiness was observed for seasoned extrudates initially as well as after six months of storage period. The decrease in crispiness was observed from third to sixth month, whereas the changes in crispiness varied from 57.00 to 33.00 during storage period of six month. These results are in line with the fact that frying of the extrudates had considerably improved the crispiness of the extrudates by removing the moisture from the surface and intercellular components of the extrudate sample as compared to un-fried extrudates.

The colour L-value and b-value decreased and a-value increased for unfried, fried and seasoned extrudates respectively during storage. The minimum change in L-value was observed for seasoned extrudates, whereas minimum change in a-value and b-value was observed for unfried extrudates.

In the second phase of experimental study, the extrusion processing was carried out at varying temperatures from 110 to 140°C. It was revealed that β-carotene content and vitamin C decreased with an increase in extrusion temperature. The standard extrusion temperature 110°C was selected on the basis of maximum retention of functional components like β-carotene and Vitamin C.

The extrudates prepared were evaluated for the thermal kinetics of colour, hardness and microstructure; β-carotene; and vitamin C. The increase in L-value, b-value and decrease in a-value, crispiness, β-carotene and vitamin C in carrot pomace based rice extrudates was observed with the increase in extrusion temperature.
The decrease in L-value, b-value, crispiness, β-carotene and vitamin C, increase in a-value and hardness in carrot pomace-based rice extrudates was observed with the progress of storage. It was revealed that β-carotene content and vitamin C decreased with the increase in extrusion temperature. A harder and compact texture in microstructural study of extrudates was observed with an increase in temperature.

The study revealed that an increase in extrusion temperature resulted in the formation of more air cells and thinner cell walls and led to the formation of softer extrudate structure. The crispiness decreased due to presence of lesser number of thin cell wall in microstructure and larger air pockets at higher extrusion temperature. Extrudates showed highest damage at higher extrusion temperature 140°C.

The extruded snack foods during storage showed a profound change in the structural orientation of the fibers and cellular components of the extrudates. During the effect of storage on the microstructure, the presence of ordered arrangement of cells and fibers in compacted form was visualized and may have led to the formation of well-organized microstructures during the fifth month of storage. The presence of well-compacted organized structural orientation with very minute fissures was observed during storage of product after six months. The structure of extrudates become ordered and compacted with storage, which may be due to absorption of moisture. This explains an increase in hardness and decrease in crispiness was observed with storage period.

In the third phase of study, effect of frying time and temperature on the different extrudate properties was studied. The colour values, L and b reduced with the increase in frying temperature and time from 65.14 to 59.41 and 38.37 to 31.33 respectively, whereas colour value ‘a’ was increased from 16.26 to 17.59 with the increase in frying temperature and time. The oil absorption increased with the increase in frying time and temperature from 5.27 to 14.00.
It was observed that the free fatty acid, crispiness, colour L-value, colour b-value and β-carotene decreased from 1.04 to 0.64%, 46.33 to 28.88, 61.22 to 52.13, 35.45 to 21.21 and 30.67 to 15.60 mg/kg respectively with the increase in storage period. Peroxide value, hardness and colour a-value increased from 6.40 to 13.39 meq/kg, 10.12 to 24.32 N and 17.68 to 21.39, respectively with the increase in storage period. Oil absorption is heavily linked to moisture loss since it determines the extent of crust formation and therefore the volume that is available for oil infiltration. Oil absorption increased from 5.37 to 14.00 with an increase in temperature and time.

The hardness of extrudates increased and crispiness decreased with the increase in storage period. The presence of porous structures with fractures was seen between the long fibres with slight rough surface. The presence of connected and interconnected air cells was apparent and the presence of continuous surface with rugosity, roughness and cracked structural orientation and fractures are prominent. The presence of porous structure and air cells confirm the efficient removal of moisture from the surface of extrudates during the process of frying which may be the reason for the desirable crispiness of the extrudates.

The study concluded that the increase in colour L-values, b-values, oil absorption and decrease in colour a-values in carrot pomace based rice extrudates was observed with the increase in frying temperature and time. Frying at 180°C and for 15s was selected on the basis of product preference. Zero order models showed better results for the prediction of colour L, a, b-values and oil absorption during frying process. The decrease in free fatty acid, colour L-values, b-values, crispiness and β-carotene and increase in peroxide value, hardness and colour a-values in carrot pomace based rice fried extrudates was observed with an increase in storage period. The quantitative variation in quality attributes suggests that the product could be stored for six month duration without considerable deterioration.