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EFFECT OF FRYING MEDIA AND PACKAGING ON SHELF LIFE OF SWEET SHANKARPOULI

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Abstract- Shankarpouli was prepared by frying in four different refined oils that are Cocountoil, Palm oil, Groundnut oil and Sunflower oil. Fried shankarpouli was packed in 12 micron metallised polyester / 50 micron HDPE-LDPE at 95% vacuum. The products were exposed to 30 to 40% RH is below critical RH of 44% and 38 to 40˚C storage condition assists in increasing the rate of oxidation of the product. All the four products were withdrawn in duplicate periodically every 15 days and subjected to physico chemical and sensory analysis. The results indicated that Sunflower oil, Groundnut oil, Palm oil and Coconut oil could offer 45days, 60days, at least 90days and at least 90days shelf life respectively. For this dry product hydrolytic rancidity which is predominant in Saturated Fatty Acid (SFA) oils like Coconut oil and palm oil was not observed up to 90 days of storage period studied. The vacuum pack has a pronounced effect in increasing shelf life of the product fried in SFO and GNO which was about 15-20 days and 30 days respectively in ordinary pack.

Keywords: Shankarpouli, coconut oil, groundnut oil. Sunflower.

I. INTRODUCTION

Shankarpouli is popular snack in south and north India prepared during Diwali festival. It contains Fat, saturated fat, cholesterol, sodium, carbohydrate, dietary fiber, protein (gluten), vitamin A, calcium and iron. The moisture contents in these products range from 2-6% that equilibrate to 0.30 water activity (a_w). The fat contents vary from 25-37%. As a result of low moisture and very low a_w, the products do not support any microbial proliferation and remain stable for long periods. Shankarpouli- a crispcy sweet made of Maida, ghee, sugar and cardamom was selected. Shankarpouli was fried in four conventional refined oils, coconut oil (CNO), palm oil (PO), groundnut oil (GNO) and sunflower oil (SFO) and packed 95% evacuating the air in head space in 12.5µm Met PET/ 50µm HD LD Co ex film and the relative shelf life was evaluated under 30 to 40% RH at 38 to 40˚C (accelerated dry) storage condition. But by protecting it by moisture and oxygen by adopting suitable packaging technique its shelf life can be increase. As the studies in normal air packing was already done in FPT department of CFTRI, the methodology adopted for 95% vacuum packed product.

II. MATERIALS AND METHODS

The Maida/semolina-300g, Sugar-150g, Cardamom-1.5g, Ghee-80g, Water-75ml were obtained from the local market of Mysore. Prepared dough by addition of water to above tested ingredients. Small balls are made of dough, rolled in a roller pin and cut (diamond shape). Fried at 130 ^{0}C in 4 different oils. Analytical grade chemicals and reagents used (AR grade glacial acetic acid, anhydrous sodium sulphate, choloform, iodine, starch, alcohol, NaoH phenolphthalein, $Na_2S_2O_3$. The best result for the 95% vacuum packed shankarpouli is shelf life of GNO & SFO increase by 2-3 times.

A. Sorption studies

The humidity-moisture relationship of the product was studied at 27° C by exposing weighed quantities of the samples in petridishes to relative humidity ranging from 11 to 92 percent using appropriate saturated salt solutions (Rockland, et al, 1960).The samples were withdrawn in duplicate periodically and weighed till they attained practically constant weight or showed signs of mould growth whichever was earlier. After equilibration, the moisture content of the product exposed to different RH's was calculated by adding / subtracting percentage pickup/loss to/from the initial moisture content.

B. Properties of Packaging materials:

Based on the results of sorption studies packaging materials were selected for packaging of Shankarpouli. MET PET/HDPE-LDPE is good moisture, gas barrier material and contributes to very good oxygen barrier properties. It is quite tough and stable. The inner polyethylene film provides good heat sealing characteristics. The permeability of packaging material to water vapor, oxygen and global migration tests for their safety for food contact application is very important which decides its suitability and compatibility for food packaging.

C. Determination of Water Vapour Transmission Rate (WVTR):

The WVTR was determined as per BIS (1960) method.

D. Determination of Gas Transmission Rate (GTR)

The gas transmission rate is usually expressed as CC / 24 hrs/ m^2 / atmospheric pressure. OTR (Oxygen transmission rate) was determined as per ASTM D 1434 – 82 procedure - V, volumetric method.

E. Determination of Global Migration Test (GMT):

The safety of packaging materials was evaluated by global migration tests with n-Heptanes (38 ºC/0.5 hrs) as per BIS method (1998).

F. Storage studies:

Shankarpouli stored at 30 to 40% RH at 38º C to 40º C (Accelerated dry) storage condition .The stored samples were withdrawn periodically every 15 days and analysed for the following physico chemical properties.

G. Physico-chemical properties of shankarpouli:

1. Determination of Moisture content of Shankarpouli

Percentage moisture was determined as per AACC (1983) method by drying known quantity of product to complete dryness and the percentage of moisture content was calculated from the measured weight loss.

2. Determination of Peroxide Value:

23 ml of AR grade glacial acetic acid was added to the fat extract taken in stoppered conical flask. 1ml of saturated KI solution was added to the flask and kept in dark for 1 minute. The flask was taken out and 50 ml distilled and cooled water was added immediately with vigorous shaking. The liberated Iodine was estimated by titrating against 0.01N $Na_2S_2O_3$ solution using starch as indicator as per AOCS (1990) method.

3. Determination of free fatty acid:

The chloroform extract in unstoppered conical flask was evaporated as was done for fat estimation. After evaporation 50 ml of freshly neutralized alcohol was added and warmed in the oven and is titrated against 0.01N Noah solution with phenolphthalein as indicator to determine FFA as per, AOCS (1990) method.

H. Chemical quality changes in oils due to frying

The chemical quality PV and FFA changes were observed for all four oils before and after frying**.**

I. Evaluation of Sensory analysis:

Sensory analysis was carried out for fresh and stored Shankarpouli by the following method.

1. Descriptors and panel training:

Descriptors for the product were obtained by "Free choice profiling", where the panelists were asked to describe the sample with as many suitable terms as possible for sensory quality of the product .The common descriptors chosen by more than one-third of the panel were used in the development of a score card. The panel comprised 15 judges who had experience in sensory profiling of other food product.

2. Quantitative Descriptive Analysis (QDA):

A QDA method of intensity scaling was used to evaluate the product Meilgaard, Civille (1999). The scorecard consisted of a 15 cm scale in which 1.25 cm was anchored at either ends as low and high, representing 'recognition threshold' and 'saturation threshold' respectively. The panelists were asked to mark the perceived intensity of each sensory attribute listed on the scorecard by drawing a vertical line on the scale and writing the code. Testing was conducted in a sensory laboratory at temperature of 20±2˚C, comprising individual booths with good ventilation, under fluorescent lighting equivalent to day light conditions.

J. Statistical analysis

1. Analysis of Variance

The data obtained from the physico-chemical and sensory analysis was subjected to statistical analysis by using analysis of variance techniques.

III. RESULTS AND DISCUSSION

A. Product standardization:

Maida-100g, sugar-50g, ghee-16g, water-25ml, shankarpouli with Crisp and good texture obtained. Hence the same quantity was used in the recipe throughout the study.

B. Sorption studies of product:

In Sorption studies humidity-moisture relationship of the product was studied at 27^0C by exposing weighed quantities of the samples in petridishes to relative humidity ranging from 11 to 92% using appropriate saturated salt solutions similar to reviewed by **Rockland, et al, (1960).**

C. Moisture sorption isotherm:

The sorption isotherm of a food material is a curve showing the equilibrium moisture content vs. the relative humidity or water activity (a_w) of the vapour space surrounding the material similar to reviewed by **Van den Berg and Bruin, (1981).**

D. Properties of packaging materials

Metallised film is good barrier for oxygen and water vapour. Since RH of the storage condition is less than critical RH for the product, WVTR will not make an important criterion of selection of packaging material for the product. The ideal packaging material should be inert and resistant to hazards and should not allow molecular transfer from or to packaging materials similar to reviewed by **Robertson, (2006).**

E. Changes in oil quality due to frying:

PV and FFA increase due to frying as to be excepted due to increase in temperature.PV and FFA values for fresh oil were 3.1 and 0.18 , 2.8 and 0.16,2.2 and 0.12,4.2 and 0.23 respectively for CNO,PO,GNO and SFO.PV and FFA values for fried oil were 6.1 and 0.25,13.4 and 0.34,9.8 and 0.28,16.8 and 0.28 respectively for CNO,PO,GNO and SFO. Thus, after frying PV and FFA gets increase. Fresh as well as fried oil CNO and PO has less PV and FFA values compared to GNO and SFO due to presence of saturated fatty acid.

Sr. No.	Oil	Fresh oil		Fried oil	
		PV	FFA	PV	FFA
1	CNO	3.1	0.18	6.1	0.25
2	PO	2.8	0.16	13.4	0.34
3	GNO	2.2	0.12	9.8	0.28
4	SFO	4.2	0.23	16.8	0.28

Table1: Chemical quality changes in oil due to frying

F. Evaluation of physico-chemical changes during Storage:

Storage studies were conducted on 95% vacuum packed shankarpouli in suitable size pouch of 12.5µm Met PET/ 50µm HDPE-LDPE and the relative shelf life was evaluated under 30 to 40% RH at 38 to 40˚C (accelerated dry) storage condition. Shankarpouli fried in four different oils and packed as above was exposed to 30-40% RH and 38-40˚C (accelerated) storage condition. This storage condition was selected based on the results of sorption studies to fix critical relative humidity of product , so that the product always will be crisp as it is below its critical RH and high temperature enhances the oxidation. The products were withdrawn periodically every 15 days and analyzed for physico-chemical parameters. The hard pack formed due to

vacuum packaging did not crush the product at 95% vacuum. Hence 95% vacuum was selected for studies

G. Changes in physico-chemical properties of shankarpouli

1. Moisture Changes

Practically there was no change in the moisture content of the product. The ERH of the product is 11% at 27˚ C and the storage atmosphere is 30 to 40% and gradient is only 29 to 39%**.** This gradient further reduces at 38-40˚C. So, moisture permeability into the package will be very less.

2. PV Changes:

The PV has changed from 1.4 to 2.1only in 90 days in shankarpouli fried in CNO. Having less PUFA.Shankarpouli fried in palm oil where the PVchages from 1.4 to 16.0 only .Fried in GNO PV changes from 4.2 to 22.0. PV changes from 15.3to 41.8 in shankarpouli fried in SFO after 90 days storage.PV values are high in GNO and SFO after 90 days compared to CNO and PO and the rate reaction is high due to the presence of the unsaturated fat smiliar to reviewed by **Arya, (1992).** . The PV of freshly fried products is less than the fried oil. This may be due to the longer exposure of oil to higher temperature (at 130^0 C) than the product.

3. FFA Changes:

The maximum FFA changes are from 0.10 to 0.52 for Coconut oil, 0.10 to 0.57 in Palm oil, 0.11 to 0.67 in Groundnut oil and 0.23 to 1.80 in Sunflower oil packed in MET-PET after 90 days. Normally PV change will be more in oils with higher PUFA and FFA change will be more in oils with higher SFA. As per that the changes in FFA should have the more in the order of CNO> PO> GNO> SFO. But the results have indicated the other way, where FFA is more in SFO> GNO> PO> CNO. This may be due to breakdown of peroxides and formation of short chain fatty acids and not due to oleic acid in case of sunflower and groundnut oils.

H. Effect of frying media CNO on shelf life of product:

The physico-chemical changes in shankarpouli fried in CNO is observed and calculated at the interval of 15 days during the storage period of 90 days. CNO has significance effect on shankarpouli up to 90 days.

Table2 : Physico chemical changes in shankarpouli fried in Coconut oil during storage.

Packaging Material	Storage Period (Days)	Moisture Content (%)	PV	FFA	Overall quality
Met PET/ HDPE-LDPE	**15**	1.48	1.6	0.13	9.7±1.2
	30	1.6	2.8	0.11	8.2±1.2
	45	1.74	2.6	0.14	9.6±0.6
	60	1.85	1.0	0.21	9.6±1.2
	75	1.92	2.0	0.34	9.5±1.3
	90	1.99	2.1	0.52	9.5±1.2

I. Effect of frying media Palm oil (PO) on shelf life of product:

The physico-chemical changes in shankarpouli fried in PO is observed and calculated at the interval of 15 days during the storage period of 90 days. PO has significance effect on shankarpouli up to 90 days.

Table3: Physico chemical changes in shankarpouli fried in Palm oil during storage.

Packaging Material	Storage Period (Days)	Moisture Content (%)	PV	FFA	Overall quality
Met PET/ HDPE-LDPE	**0**	1.33	1.4	0.1	10.5±0.7
	15	149	4.3	0.11	9.7±1.3
	30	1.6	6.7	0.17	10.0±1.1
	45	1.66	8.1	0.2	10.0±0.2
	60	1.72	11.6	0.24	9.1±1.5
	75	1.77	13.5	0.39	8.7±1.1
	90	1.82	16.0	0.57	8.9±1.1

J. Effect of frying media Groundnut oil during storage (GNO) on shelf life of product:

The physico-chemical changes in shankarpouli fried in GNO is observed and calculated at the interval of 15 days during the storage period of 90 days. GNO has significance effect on shankarpouli up to 60 days.

Table4: Physico- chemical changes in shankarpouli fried in Groundnut oil during storage.

Packaging Material	Storage Period (Days)	Moisture Content (%)	PV	FFA	Overall quality
Met PET/ HDPE-LDPE	**0**	1.33	4.2	0.11	10.6±1.2
	15	1.5	5.2	0.14	8.6±1.3
	30	1.62	7.0	0.19	7.9±1.0
	45	1.72	11.0	0.20	7.9±1.2
	60	1.79	15.0	0.25	9.2±1.4
	75	1.84	19.1	0.42	Highly Rancid
	90	1.89	22.0	0.67	Highly Rancid

K. Effect of frying media Sunflower oil (SFO) on shelf life of product:

The physico-chemical changes in shankarpouli fried in SFO is observed and calculated at the interval of 15 days during the storage period of 90 days. SFO has significance effect on shankarpouli up to 45 days.

Table5: Physico-chemical changes in shankarpouli fried in Sunflower oil during storage

Packaging Material	Storage period (Days)	Moisture Content (%)	PV	FFA	Overall quality
Met PET/ HDPE-LDPE	**0**	1.33	15.3	0.23	10.2±1.3
	15	1.39	35.4	0.24	7.8±1.0
	30	1.47	50.5	0.32	7.8±0.1 Not acceptable
	45	1.52	68.0	0.48	6.7±0.5 Just acceptable
	60	1.59	95.0	0.65	Rancid
	75	1.65	50.3	1.00	Rancid
	90	1.72	41.8	1.80	Rancid

L. Changes in Physico chemical properties:

1. Moisture Changes:

Practically there was no change in the moisture content of the product. The ERH of the product is 11% at 27˚ C and the storage atmosphere is 30 to 40% and gradient is only 29 to 39%**.** This gradient further reduces at 38-40˚C. So, moisture permeability into the package will be very less. This is further reduced owing to good barrier property of packaging materials. Hence the selection of storage condition and packaging material is justified as there is no moisture gain by the product.

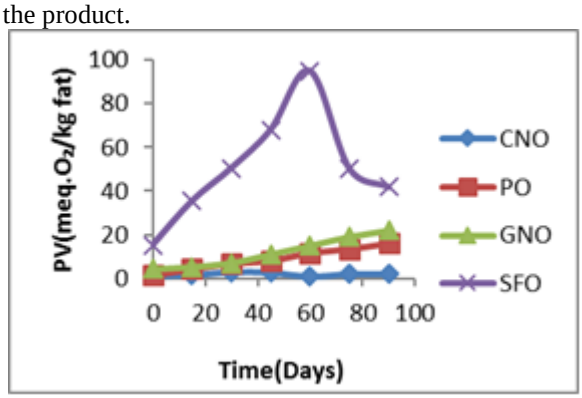

Fig.2.-Moisture content graph of Shankarpouli stored in Met PET/ HDPE-LDPE

2. PV Changes:

The PV has changed from 1.4 to 2.1only in 90 days in shankarpouli fried in CNO .Having less PUFA reaction rate is slow due to the presence of saturated fat. Shankarpouli fried in palm oil where the PVchages from 1.4 to 16.0 only .Fried in GNO is from 4.2 to 22.0 .15.3to 41.8 in shankarpouli fried in SFO after 90 days storage.PV values are high in GNO and SFO after 90 days compared to CNO and PO and the rate reaction is high due to the presence of the unsaturated fat . The PV of freshly fried products is less than the fried oil. This may be due to the longer exposure of oil to higher temperature (at 1300 C) than the product. The snack product fried in GNO and SFO the rate of oxidative reaction is high become rancid due to the presence of PUFA similar to Products fried in unsaturated vegetable oils which is poly unsaturated fatty acid become rancid faster than those fried in relatively saturated oils like palm oil by Arya, (1992).

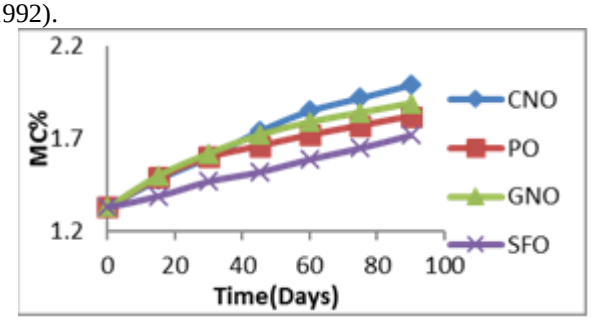

Fig.3.- Peroxide value graph of Shankarpouli stored in Met PET/ HDPE-LDPE

3. FFA Changes:

FFA changes are from 0.10 to 0.52 for Coconut oil, 0.10 to 0.57 in Palm oil, 0.11 to 0.67 in Groundnut oil and 0.23 to 1.80 in Sunflower oil packed in MET-PET after 90 days. Normally PV change will be more in oils with higher PUFA and FFA change will be more in oils with higher SFA. As per that the changes in FFA should have the more in the order of CNO> PO> GNO> SFO. But the results have indicated the other way, where FFA is more in SFO> GNO> PO> CNO. This may be due to breakdown of peroxides and formation of short chain fatty acids and not due to oleic acid in case of sunflower and groundnut oils.

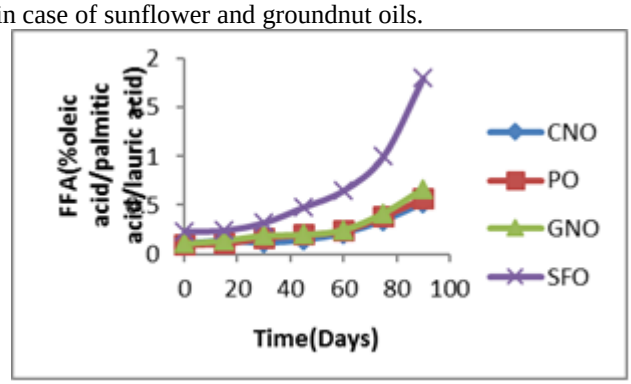

Fig.4.- Free fatty acid graph of Shankarpouli stored in Met PET/ HDPE-LDPE

M. Evaluation of sensory analysis:

1. Free-choice Profiling:

In free choice profiling analysis negative attributes like stale and rancid, bitter after taste was not found in the fresh samples. Hence panellists did not describe them. However as they were expected to appear on storage they were included in QDA score card.

2. QDA analysis:

The results of QDA analysis are depicted graphically as 'Sensory Profiles' .Off note was not observed even at 90 days in CNO and 90 days in PO fried samples. The products fried in GNO and SFO were clearly rancid by the end of 60 days and 45 days respectively .This indicates a shelf life of at least 90days, at least 90 days, 60days and 45days for the products fried in CNO, PO, GNO and SFO respectively. The vacuum packaging has pronounced effect as the corresponding shelf life was at least 60 days, at least 60days, 30 days and 15-20 days. Otherwise, in general, significant difference is not noticed for all other sensory attribute values which may be mainly due to no change in moisture contents of the product. Moisture content will be responsible for hardness, gritty, surface uniformity and to little extent brownish colour.

N. Sensory profile of shankarpouli fried in Coconut oil:

The sensory profile of shankarpouli fried in coconut oil is respect to its colour and appearance, texture, aroma and taste. The overall qualities for CNO are from 9.9 to 9.5. Which indicate shelf life of CNO for 90 days. Thus, CNO has desirable effect on fried shankarpouli.

O. Sensory profile of Shankarpouli fried in palm oil

The sensory profile of shankarpouli fried in palm oil is shown in respect to its colour and appearance, texture, aroma and taste. The overall qualities for PO are from 10.5 to 8.9. which indicate shelf life for 90 days .Thus, PO has desirable effect on fried shankarpouli.

P. Sensory profile of Shankarpouli fried in Groundnut oil

The sensory profile of shankarpouli fried in Groundnut oil with respect to its colour and appearance, texture, aroma and taste. The overall qualities for GNO are from 10.6 to 7.2. which indicate shelf life for 60 days. Thus, GNO has desirable effect on fried shankarpouli for 60 days.

Q. Sensory profile of Shankarpouli fried in Sunflower oil

The sensory profile of shankarpouli fried in sunflower oil with respect to its colour and appearance, texture, aroma and taste. The overall qualities for SFO are from 10.2 to 6.7. Which indicate shelf life for 45 days .Thus, GNO has desirable effect on fried shankarpouli for 45 days.

IV. CONCLUSION

95% vacuum packed shankarpouli fried in CNO and PO has shelf life up to 90 days due to presence of saturated fat. There was no change observed in moisture content of product practically up to 90 days in packaging material. Oxidation reaction PV was observed in Met-pet material after 60 days and 45 days in GNO and SFO.But CNO and PO did not show any relationship with OTR of packaging material. Hydrolytic reaction FFA was more in SFO due to presence of PUFA than CNO.Thus, 95% vacuum packaging increased the shelf life in GNO and SFO by 2-3 times.

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