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RESEARCH ARTICLE

THE EFFECT OF PACKAGING MATERIAL AND STORAGE DURATION ON QUALITY OF ORANGE PEEL COOKIES

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Abstract

In present investigation the orange peel powder cookies were stored in both packaging material i.e, LDP pouches (gauge 393) and aluminum pouches (gauge 157).The quality parameter i.e., LDP pouches and aluminum pouches cookies were observed during each 15 days interval upto 90 days.Nutritional analysis indicates that both packaging material and storage period increases, moisture content increases i.e., 3.12 to 6.18 % and decreasing trend in TSS 49.75 to 29.16 (°B), acidity 0.082 to 0.043 %, reducing sugar3.360 to0.970 %, non-reducing sugar 24.513 to 17.582 % , total sugar 28.383 to 18.290 %, ascorbic acid 48.037 to 17.710 % and colour 9.348 to 10.718 and microbiological study depicted that microbial count was far below the permissible limit up to 3 month of storage of cookies in LDP and aluminumpouches.

Introduction:-

Citrus fruits have long been valued as a part of nutritious and tasty diet. It is well established that citrus and citrus products are rich source of vitamins, minerals and dietary fibers that are essential for normal growth and development and overall nutritional well-being (Economos and Clay, 1999), and causes a higher amount of byproducts that could be used as good source of bioactive compounds (Saenz et al., 2007, Kong et al., 2010).

The bioflavonoids, hesperidin and naringin present in citrus fruits have been reported to exhibit biological and pharmacological properties like anti-inflammatory, anti: carcinogenic, lipid lowering and antioxidant activities (Bok et al.,1999; Choi et al., 2001). Hesperedin and naringin have also been shown to play an important role in preventing the progression of hyperglycemia (Jung et al., 2004). Naringin has been reported to serve as a potential therapeutic agent to treat wear- debries- associated osteolysis (Li et al., 2014), and Osteoporosis (Wei et al., 2007). Some of these bioflavonoids are bitter to the taste and their presence in fruit juices and products developed from it are sometimes inevitable, which lowers the consumer's acceptability. (Jagannath and Kumar, 2016).Bakery products are an important part of a balanced diet and, today, a wide variety of such products can be found on supermarket. The most important quality shelves. Cookies comprise a major category of snacks by virture of their general acceptability, convenience and long shelf life. The cookies are characterized by moisture and water activity (a_w) higher then 7 % and 0.5 % (Lebuza, 2002). The short is usually a mixture of several ingredient, made according to fairly complex recipe and in a short time (Manley, 1998). Texture, flavor and appearance are the main attribute of

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cookies. Fat is very important ingredient of cookies because it contribute texture and pleasuring mouth feel and positively impact flavor intensively perception. In many countries cookies are prepared with fortified and composite flour. Replacing the part of wheat flour with rice flour, soy flour is likely to improve nutritive value of product due to various nutritive supplement like amino acid profile derived from these raw material (Baker et al., 1985; Cheryan et al., 1979). Cookies are usually stored at room temperature and very often packed in composite flexiablematerals with a high barrier or both oxygen and water vapour. The most important quality deterioration phenomena during storage are loss of crispness and lipd oxidation, due to moisture uptake and their high fat content, as well as aroma loss; microbiological spoilage does not generally represent a problem (Smith et al 2004;Robertson 2006; Galic et al 2009). Quality preservation of complex multi-domine foods, such as biscuits, appers complicated due to the different physicochemical phenomena that simultaneously take place during storage, those leading to several changes that limit product shelf-life. Since oxidation reactions are triggered by the presence of oxygen and light, and loss of crispness is due to moisture uptake from the surrounding environment, an appropriate packaging with high barrier to water vapor, light and oxygen is required to prevent or to slow down the rate of quality deterioration of cookies during storage (Smith et al 2004; Robertson 2006; Farris et al., 2009).

The Low density polyethylene (LDPE)and aluminum coated pouches iswidely used to package in small scale industries and are popularly used packaging material for storage of processed food products. The challenge is to develop cookies, a higher consumed bakery product, using fruit waste to increase functional ingredients for daily intake. Consumer awareness of the functional characteristics of the food product is increasing, which is influencing their purchasing decisions. (Piteriaet al., 1988). An alternative for recycling the fruit industrial residue is to submit it to drying processes. Dehydrated of orange peel powder could be used in the formulation of cookies. The purpose of the present study was effect of two different packaging material and storage duration up to 3 months on developed orange peel cookies in ambient temperature and its physicochemical and sensorial characteristics.

Material and Methods:-

Preparation of Orange peel cookies:-

Fig. 2 shows the process technology for preparation of orange peel cookies. The 28g sugar and 30g (%) vegetable oil were creamed and creaming was continued till it become light and fluffy mass. The mixture was added with the refined wheat flour 39% and orange peel powder as 3% prepared with blanching orange peels at 82°C for 8 min and dried at 50°C for 11 h30 min up to moisture content 15.379 (%db) and grounded to make the flour composition according to the treatment, and it were added into the earlier creamed mass and they were thoroughly mixed to a homogeneous mixture to form dough. The dough was taken into mould for giving shape to the cookies. The cookies were placed in a baking tray and baked in oven at about 190°C for 20-25 min. The sample were cooled at 25°C temperature and packedfor quality analysis and transferred into low density polyethylene pouches size 15× 9 cm and aluminum pouches stored at normal temperature. Table 1 shows the experiment level of orange peel cookies. Cookies were compared with the control sample with 40°C dried orange peel powder incorporated in 1% concentration baked at temperature 190°C.

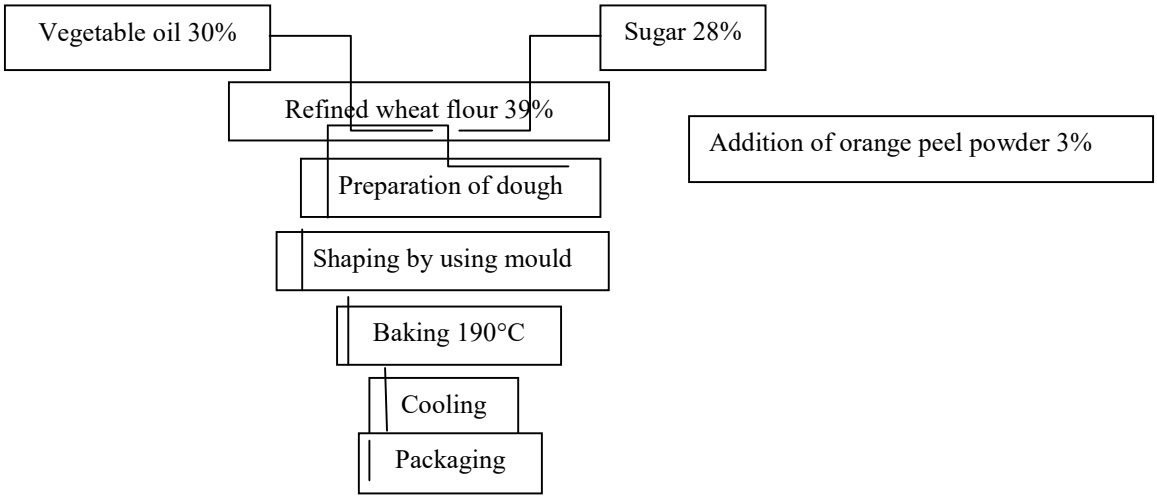

Fig 1: Process technology for orange peel cookies

Packaging and storage study of Orange peel cookies:-

The best treatment of orange peel cookies of 3% orange peel powder was prepared and was used for the packaging and storage study. 50 g of orange peel cookies were prepared as discussed above and taken in two different packaging material i. e. polythene and aluminum pouches. The details of the packaging material are given in Table 1. Figure 2 (a) and 2 (b) shows the packaging material i. e. polythene and aluminum laminated pouches used for packaging and storage oforange peel cookies for 3 months duration.

Table 1. Specifications of packaging material for storage of orange peel cookies

Sr. No.	Packaging material	Size	Gauge	Capacity
1	Polythene pouches	15 cm × 9 cm	393	50 g
2	Aluminium laminated pouches	13 cm × 9 cm	157	50 g

Fig2(b)

Fig2(a)

Fig. 3: Packaging material used for packaging of orange peel cookies. (a) Polythene pouch (b) Aluminum laminated pouch.

50 g of orange peel cookies sample was filled separately in polythene and aluminum laminated pouches and sealed properly. These packets were kept at ambient temperature up to 12 weeks. The stored samples were analyzed at every 15 days interval up to 3 months. The observations for the sensory analysis, TSS, Acidity, Reducing sugar, total sugar, Ascorbic acid, Browning index and microbial analysis of stored sample were taken during 7 duration (0, 15, 30, 45, 60, 75 and 90days) i.e. total no. of samples for all the trials were, 7 duration × 2 packaging material ×3 replication = 30 samples of orange peel cookies were kept for storage study. The sensory analysisi.e.colour, flavor, texture, Taste and Overall acceptability and microbial analysis i.e. colony forming unit (CFU/g of sample) for the stored samples were determined for each storage duration i. e. 0, 15, 30, 45, 60, 75 and 90 days.

Storage studies:

The orange peel cookies packed in polythene and aluminium laminated pouches samples were subjected to storage studies at ambient (30±1°C). The samples stored at ambient temperature were analyzed at 15 daysinterval up to 90 days for Physicochemical properties TSS, Acidity, Reducing sugar, total sugar, Ascorbic acid, browning index and microbial analysis sensory qualities like colour, flavour, textureand Overall acceptability and monthly analysis for microbial count i.e. standard plate counts (SPC).

Evaluation of Quality Parameter for the blanched dried of Orange peel cookies:-

TSS (ºB):-

The Total SolubleSolids of orange peel cookies were determined by using Hand Refractometer (M/s Atago Japan, 0-32^{0}B) and the values were corrected at 20^{0}C with the help of temperature correction chart (A.O.A.C., 1975). The equipment was calibrated with the distilled water. The experiments were repeated four times and average value was reported.

Titratable acidity:-

A 10g of orange peel cookies was performed as per (A.O.A.C., 1975) sample was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator (A.O.A.C., 1975). The sample of known quantity with 20 ml distilled water was transferred to 100 ml volumetric flask, made up the volume and filtered. A known volume of aliquot (10 ml) was titrated against 0.1N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (Ranganna, 2003). The results were expressed as per cent anhydrous citric acid equation (9). The experiments were repeated for three times and average value was reported

$$\text{Titratable acidity}(\%) = \frac{\text{Normality of alkali X Titre reading X Volume made X Equivalent weight of acid}}{\text{Weight of sample taken X Volume of sample taken for estimation X 1000}} \text{X100} \quad \ldots (2)$$

Reducing sugars:-

The reducing sugars of orange peel cookies were determined by the method described by Ranganna (2003). A 25g oforange peel cookies of various treatments (T_1-T_{16}) was taken in 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1 N sodium hydroxide. Then 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Two ml of 22 per cent potassium oxalate was added to it to precipitate the excess of lead. The volume was made to 250 ml with distilled water and solution was filtered through Whatman (No. 4) filter paper. This filtrate was used for determination of reducing sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' solutions (5 ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis equation (10).

$$\text{Reducing sugars (\%)} = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{ X 100} \quad \ldots (3)$$

Non-Reducing sugar:-

The non-reducing sugar of orange peel cookies was determined by subtracting reducing sugar from total sugars per the equation (4).

Non-Reducing sugar = [(Total sugar % - Reducing sugar) 0.95] … (4)

Total sugars:-

The total sugar of orange peel cookies was determined as per Ranganna (2003).For inversion at room temperature, a 50 ml aliquot of clarified deluded solution was transferred to 250 ml volumetric flask, to which, 10 ml of 50 per cent HCl was added and then allowed to stand at room temperature for 24 hrs. It was then neutralized with 40 per cent NaOH solution. The volume of neutralized aliquot was made to 250 ml with distilled water. This aliquot was used for determination of total sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' (5ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis as per equation (11). The experiments were repeated four three times and average value of total sugar have been reported.

$$\text{Total sugars (\%)} = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{X 100} \quad \ldots (5)$$

Ascorbic acid:-

Ascorbic acid of orange peel cookies was determined in triplicate by titration. 10g of sample was taken and blended with 3g/dL HPO_3. the total volume was madeupto 100 ml with HPO_3. This was followed by titration. An aliquot of 10 ml HPO_3 was taken as extract of the sample. The sample was titrated with the standard dyeto an end point (pink color) that was persisted for atlest 15 second(AOAC 1968). Results will be expressed as mg of ascorbic acid/100 g of sample.

$$\text{Mg of ascorbic acid/100 g of sample} = \frac{\text{Titre} \times \text{Dye Factor} \times \text{Volume made up} \times 100}{\text{Aliquotof extract taken for estimation} \times \text{Weight of volume of sample taken for estimation}} \quad \ldots (6)$$

Colour:-

The orange peel cookies were used to measure the colour value using a colorimeter (M/S Konica Minolta, Japan Model- Meter CR-400). The equipment was calibrated against standard white tile. Orange peel cookies were taken in the petri dish, the petri dish was placed at the aperture of the instrument. The colour was recorded in terms of L= lightness (100) to darkness (0); a = Redness (+60) to Greeness (-60); b= yellowness (+60) to blueness (-60). The browning index of the orange peel cookies was determined from the L, a, and b values as per the equation (15) reported by (Perez-Gago, Serra, & Del Rio, 2006).The brown index (BI) was determined using the following equation: Thisindex indicates the brown color purity which can be calculated in this way

$$B_I = \frac{100\times(\chi-0.31)}{0.172} \ldots (7)$$

$$\chi = \frac{a*+1.75\ *}{5.645L*+a*-3.012b*}$$

Sensory analysis:-

The orange peel cookies packed in polythene and aluminium laminated pouches was determined for each storage period 0, 15, 30, 45, 60, 75 and 90 days with trained panelists as per nine point hedonic scale. The Panelists were trained for the product testing and were familiar with product sensory evaluation. The orange peel cookies samples were placed into plate. The Orange peel cookies packed in polythene and aluminium laminated pouches were coded as A and B for evaluation of sensory parameter i.e.colour,flavor, texture and mouth feel attributes. The rating was based on nine- point hedonic scales.09 scales for colour, 9 scales for flavor attribute 09 scales for texture attribute and 09 scales for Taste. The attribute were summed up for total score 36 for each panelist for each treatment. The average score for total 14 panelists have been reported. The data were analyzed statistically for the significance of each attributes by ANOVA.

Microbial analysis:-

The microbial analysis of dried orange peel cookies packed in polythene and aluminium laminated pouches was determined for storage period of0, 15, 30, 45, 60, 75 and 90 days i.e. after 15 days of interval as per the procedure of APHA (1992). The cookies samples were analyzed for standard plate counts (SPC) using nutrient agar medium and potato dextrose agar medium (Himedia Laboratories Pvt. Ltd. Bombay).

The sample was crushed finely in mortar and pestle. 1gm of sample was mixed thoroughly in 10ml autoclaved distilled water and mixed thoroughly by vortexing. Serial dilutions from the above suspension were prepared up to 10^{-6}.1 ml serially diluted sample was plated by pour plate technique on nutrient agar (for total viable count), Potato Dextrose Agar (for yeast and mold count. Bacterial plate were incubated at 32°C for 3 days andyeast and mold plate were incubated for 22.5°C for 5 days.After incubation the plates were observed for typical colonies of each microorganism and colonies were counted with the help of colony counter. The results were recorded as CFU/gmmethods prescribed by Bureau of Indian Standards, (1999).

Formula for calculating CFU/g

$$\text{CFU} = \frac{\text{Average plate count}\times\text{Dilution}}{\text{Weight of sample}} \quad \ldots(2)$$

Statistical analysis:-

Statistical analysis was performed using 3 Factorial completelyrandomized design (FCRD) for stored sample properties ofTSS, Acidity, Reducing sugar, total sugar, Ascorbic acid, Browning index and microbial analysis sensory qualities like colour, flavour, texture, taste and Overall acceptabilityand microbial analysis packed in polythene and aluminum laminated pouches for 0, 15, 30, 45, 60, 75 and 90 days was carried out by Microsoft Excel 2007.

Result Dissuasion:-

TSS(°B):-

Theeffect ofpackaging material andstorage duration (0, 15, 30, 45, 60, 75 and 90 days)on TSS (°B) of orange peel cookies is shown in Fig. 4. The TSS (°B) of orange peel cookies which was packed in polythene pouches were 49.16, 45.11, 41.55, 39.90, 31.935, 26.46 and 22.11 (°B)for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the TSS of orange peel cookies which was packed in aluminum pouches were 49.75, 46.64, 43.27, 37.77, 34.74, 29.32, and 25.45 (°B) for 0, 15, 30, 45, 60, 75 and 90 daysof storage respectively. From Fig. 4 it is clear that as storage period increases, the TSS (°B) of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 2 (a) shows the ANOVA for the effect of packaging material and storage duration on TSS(°B)of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material and storage duration had significant influence on TSS (°B) oforange peel cookies at p≤0.05. The interaction also shows the significant influence on TSS of orange peel cookies at p≤0.05. Hosamaniet al., 2016 aluminium pouches TSS is higher then polythene pouches, as the storage period increases TSS decreases.; Devi et al., 2012 also reported the similar result on TSS. Metallised polyester polyethylene Laminated pouches TSS is higher then polythene pouches and plastic container, as the storage period increases TSS decreases.

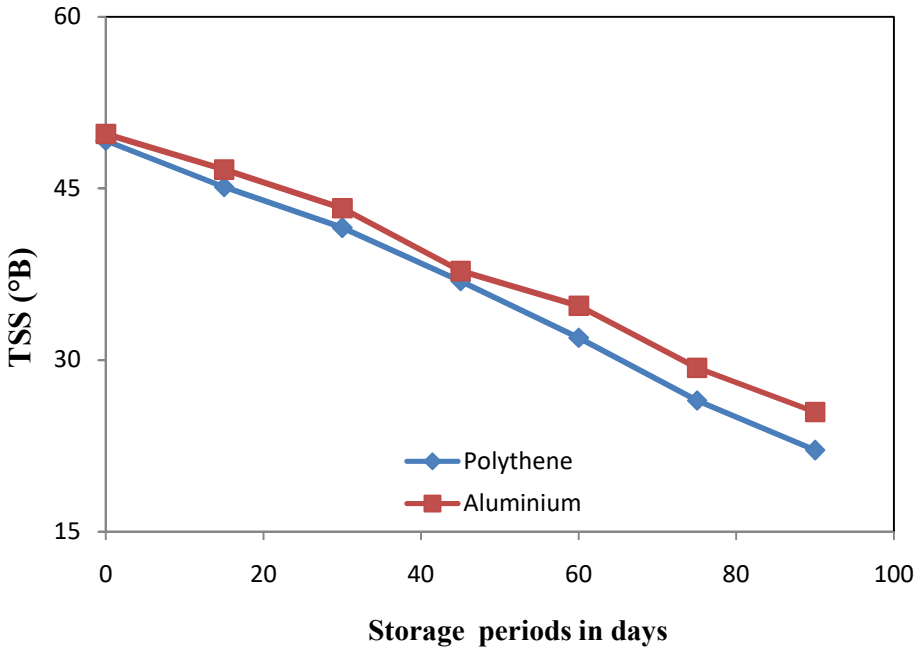

Fig. 3 Effect of packaging material and storage duration on TSS (°B) of orange peel cookies stored upto 90 days

Acidity:-

Theeffect of packaging material andstorage duration (0, 15, 30, 45, 60, 75 and 90 days) on Acidity of orange peel cookies is shown in Fig. 5. The Acidity of orange peel cookies which was packed in polythene pouches were 0.093, 0.073, 0.058, 0.055, 0.049, 0.046 and 0.043 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the acidity of orange peel cookies which was packed in aluminum pouches were 0.082, 0.072, 0.065, 0.058, 0.054, 0.054 and 0.053 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 5 it is clear that as storage period increases, the acidity of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 3 (b) shows the ANOVA for the effect of packaging material and storage duration on acidity of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging treatments had no significant influence onacidity of orange peel cookies at p≤0.05 but storage duration had significant influence on acidity of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also showed no significant influence on orange peel cookies at p≤0.05.Hosamaniet al., 2016 aluminium pouches acidity is higher than polythene pouches, as the storage period increases acidity decreases.; Devi et al., 2012 also reported the similar result on acidity. Metallised polyester polyethylene Laminated pouches acidity is higher than polythene pouches and plastic container, as the storage period increases acidity decreases.

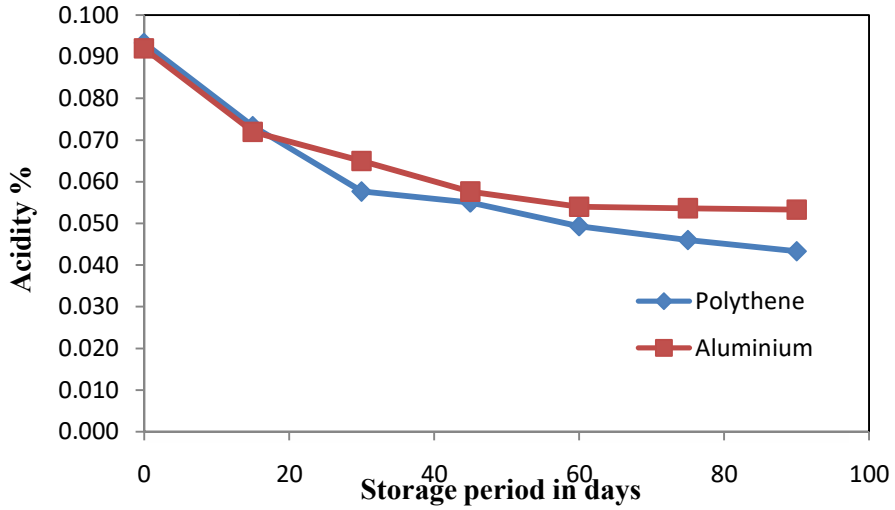

Fig. 4 Effect of packaging material and storage duration on Acidity (%) of orange peel cookies stored upto 90 days

Reducing sugar:-

Theeffect of packaging material and storage duration (0, 15, 30, 45, 60, 75 and 90 days)on reducing sugar % of orange peel cookies is shown in Fig. 6. The reducing sugar % of orange peel cookies which was packed in polythene pouches were 3.360, 2.865, 2.699, 2.152, 1.857, 0.876 and 0.745 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the reducing sugar % of orange peel cookies which was packed in aluminum pouches were 3.234, 2.853, 2.361, 2.162, 1.792, 1.607 and 0.970 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 5it is clear that as storage period increases, the reducing sugar % of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 3 (c) shows the ANOVA for the effect of packaging material and storage duration on reducing sugar % of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material had no significant influence onreducing sugar % of orange peel cookies at $p \leq 0.05$ but storage duration had significant influence on reducing sugar % of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also showed no significant influence on orange peel cookies at $p \leq 0.05$.Hosamaniet al., 2016 aluminium pouches reducing sugar is higher than polythene pouches, as the storage period increases reducing sugar decreases.; Devi et al., 2012 also reported the similar result on reducing sugar. Metallised polyester polyethylene Laminated pouches reducing sugar range from 5.60 to 5.98 is higher than polythene pouches and plastic container, as the storage period increases reducing sugar decreases.

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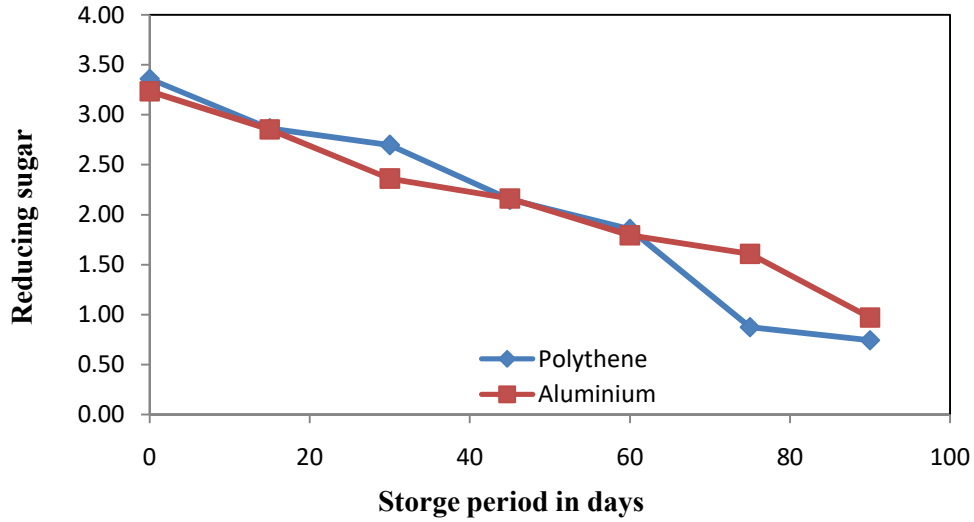

Fig. 5 Effect of packaging material and storage duration on Reducing sugar (%) of orange peel cookies stored upto 90 day

Non-reducing sugar:-

Theeffect of packaging material and storage duration (0, 15, 30, 45, 60, 75 and 90 days)on Non-reducing sugar % of orange peel cookies is shown in Fig. 6. The Non-reducing sugar % of orange peel cookies which was packed in polythene pouches were 23.529, 21.552, 20.178, 19.456, 19.277, 19.021 and 17.582 % for 0, 15, 30, 45, 60, 75 and 90 days respectively of storage and the Non-reducing sugar % of orange peel cookies which was packed in aluminum pouches were 24.513, 20.900, 21.091, 19.679, 19.858, 19.207 and 18.284 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 7 it is clear that as storage period increases, the Non-reducing sugar % of orange peel cookies packed in polythene pouches and aluminum pouches decreases. Table 2 (d) shows the ANOVA for the effect of packaging material and storage duration on Non-reducing sugar % of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material had no significant influence onNon-reducing sugar % of orange peel cookies at $p \leq 0.05$ but storage duration had significant influence on Non-reducing sugar % of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also showed no significant influence on orange peel cookies at $p \leq 0.05$.Hosamaniet al., 2016 reported that as the storage period increases non-reducing sugar decrease.

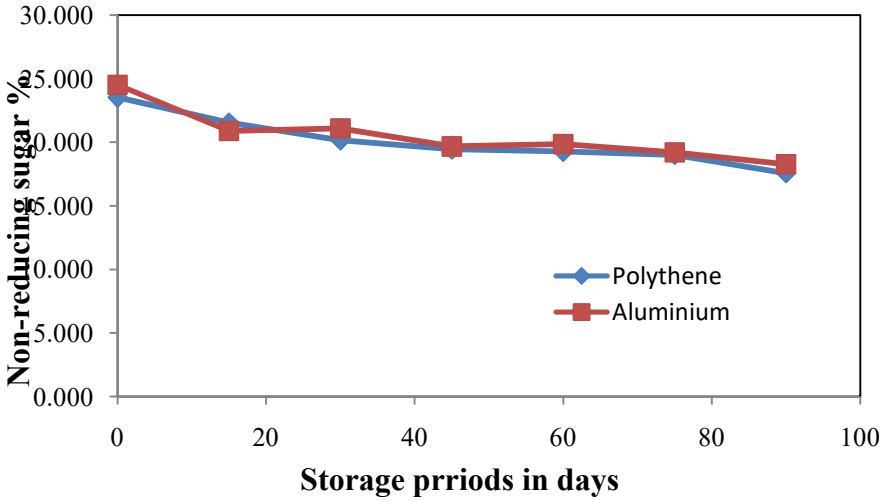

Fig. 6 Effect of packaging material and storage duration on Non-reducing sugar (%) of orange peel cookies stored upto 90 day

Total sugar:-

Theeffect of packaging material and storage duration (0, 15, 30, 45, 60, 75 and 90 days)on Total sugar % of orange peel cookies is shown in Fig. 8. The Total sugar % of orange peel cookies which was packed in polythene pouches were 27.788, 24.274, 22.741, 21.501, 21.041, 19.854 and 18.290 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the Total sugar % of orange peel cookies which was packed in aluminum pouches were 28.383, 24.024, 23.334, 21.733, 21.561, 20.720 and 19.206 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 8 it is clear that as storage period increases, the Total sugar % of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 2 (e) shows the ANOVA for the effect of packaging material and storage duration on Total sugar % of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material had significant influence onTotal sugar % of orange peel cookies at $p \leq 0.05$ the storage duration had also significant influence on Total sugar % of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also showed no significant influence on orange peel cookies at $p \leq 0.05$.Hosamaniet al., 2016 aluminum pouches total sugar is higher than polythene pouches, as the storage period increases TSS decreases.; Devi et al., 2012 also reported the similar result on total sugar. Metallized polyester polyethylene Laminated pouches total sugar is higher than polythene pouches and plastic container, as the storage period increases total sugar decreases.

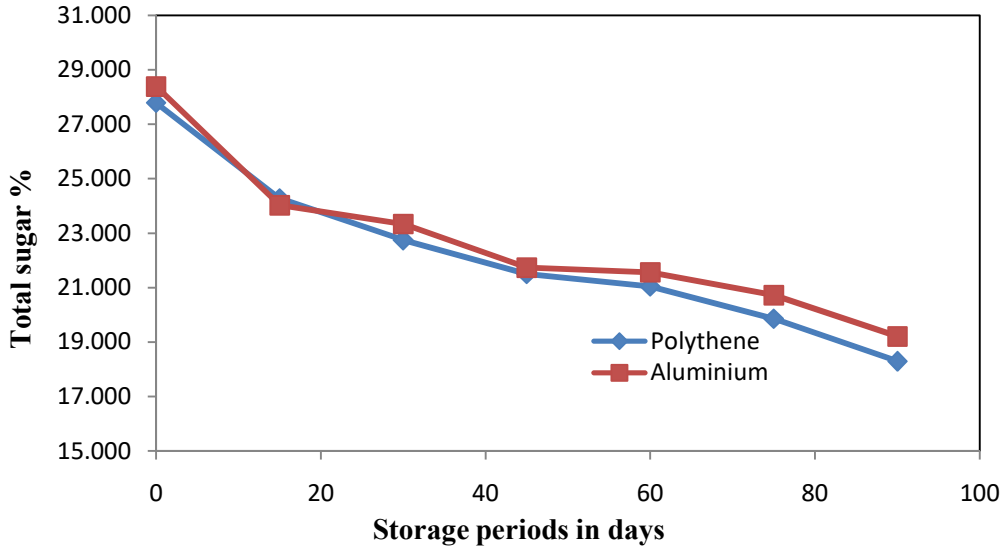

Fig. 7 Effect of packaging material and storage duration on Total sugar (%) of orange peel cookies stored upto 90 day

Ascorbic acid:-

Theeffect of packaging material and storage duration (0, 15, 30, 45, 60, 75 and 90 days)on ascorbic acid % of orange peel cookies is shown in Fig. 8. The ascorbic acid % of orange peel cookies which was packed in polythene pouches were 48.032, 40.950, 37.450, 31.897, 27.313, 22.403 and 17.710 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the ascorbic acid of orange peel cookies which was packed in aluminum pouches were 47.737, 44.113, 40.563, 37.853, 34.040, 30.173 and 25.273 % for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 9 it is clear that as storage period increases, the ascorbic acid % of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 2 (f) shows the ANOVA for the effect of packaging material and storage duration on ascorbic acid % of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material and storage duration had significant influence on ascorbic acid % of orange peel cookies at $p \leq 0.05$. The interaction also shows the significant influence on ascorbic acid % of orange peel cookies at $p \leq 0.05$.Hosamaniet al., 2016 aluminium pouches TSS is higher than polythene pouches, as the storage period increases ascorbic acid decreases.; Devi et al., 2012 also reported the similar result on ascorbic acid. Metallized polyester polyethylene Laminated pouches

ascorbic acid is higher than polythene pouches and plastic container, as the storage period increases ascorbic acid decreases.

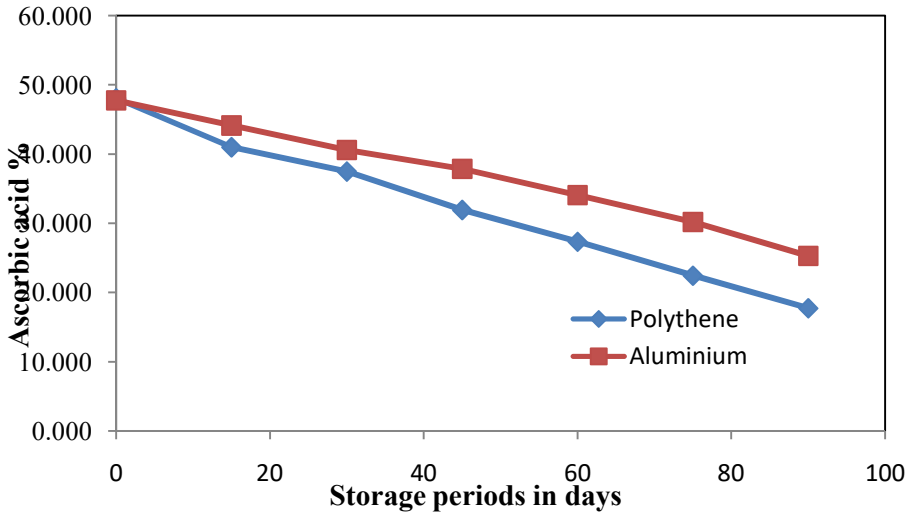

Fig. 8 Effect of packaging material and storage duration on ascorbic acid (%) of orange peel cookies stored upto 90 day

Browning Index:-

Theeffect of packaging material and storage duration (0, 15, 30, 45, 60, 75 and 90 days)on Browning Index of orange peel cookies is shown in Fig. 9. The Browning Index of orange peel cookies which was packed in polythene pouches were 12.591, 11.699, 11.817, 12.305, 10.525, 9.846 and 10.119 for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively and the Browning Index of orange peel cookies which was packed in aluminum pouches were 9.348, 13.011, 11.367, 10.321, 10.727, 9.953, and 11.138 for 0, 15, 30, 45, 60, 75 and 90 days of storage respectively. From Fig. 10 it is clear that as storage period increases, the Browning Index of orange peel cookies packed in polythene pouches and aluminum pouches decreases.

Table 2 (g) shows the ANOVA for the effect of packaging material and storage duration on Browning Index of orange peel cookies at 0, 15, 30, 45, 60, 75 and 90 days of storage. It indicated that packaging material had no significant influence onBrowning Index of orange peel cookies at $p \leq 0.05$ but storage duration had significant influence on Browning Index of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also showed significant influence on orange peel cookies at $p \leq 0.05$.Hosamaniet al., 2016 reported that aluminum pouches retain more colour, as the storage period increases colour decreases.

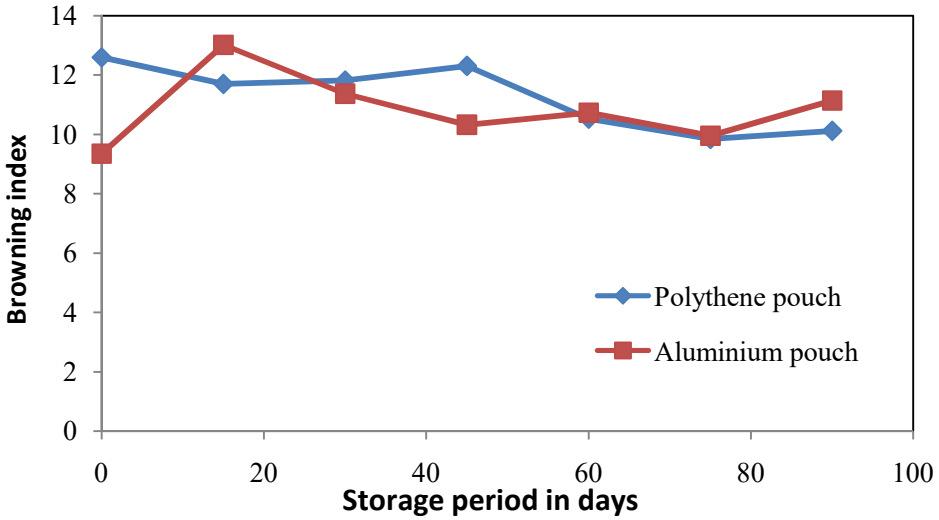

Fig. 9 Effect of packaging material and storage duration on Browning index of orange peel cookies stored upto 90 day

Microbial analysis:-

Standard Plate Count:-

The effect of packaging material (polythene pouches and aluminum pouches) and storage duration on microbial characteristics of orange peel cookies stored at ambient temperature were recorded and presented in Table 3. Out of total storage duration i.e. 0, 15, 30, 45, 60, 75 and 90 days, the microbial analysis was carried out after 15 days interval. Bacterial growth was detected for fourth analysis of 45 days for both the packaging material i.e. polythene pouches and aluminum pouches. At 90 days analysis the standard plate count count observed for cookies packed in polythene and aluminum pouches were and 62×10^3CFU/ g and 73×10^3 CFU/ g respectively.

It was seen from Table 3 shows the ANOVA for the effect of packaging treatments and storage duration on standard plate count oforange peel cookies. It indicated that packaging material and storage durationhad significant influence on standard plate count of orange peel cookies at $p\leq0.05$. The interaction also shows significant influence on standard plate count of orange peel cookies at $p\leq0.05$. Sigh et al., 2017
the results were in general agreement with the results obtained 10×10^2 to 150×10^2 CFU/g
Nagi et al., 2012 also reported the similar result range from 2.20×10^2 to 59.54×10^2 CFU/g, according to Indian Standards, total bacterial count/g should not be more than 50,000 in high protein biscuits.

Table 3.Table Effect of packaging material and storage duration of orange peel cookies on standard plate count

Duration	**Polythene Pouch**	**Aluminum Pouch**
0 Days	Not Detected	Not detected
15 Days	Not Detected	Not Detected
45 Days	Not Detected	Not Detected
45 Days	14×10^2 CFU/g	8×10^2 CFU/g
60 Days	21×10^2 CFU/g	25×10^2 CFU/g
75 Days	51×10^2 CFU/g	46×10^2 CFU/g
90 Days	62×10^2 CFU/g	53×10^2 CFU/g
SE	**Packaging material (P)**	**Storage Duration (S)**	**Interaction (P×S)**

	0.503	0.94280	1.333
CD	NON SIG	NON SIG	NON SIG

Yeast and Mold Count:-

The effect of packaging material (polythene pouches and aluminum pouches) and storage duration on microbial characteristics of dried SFP, stored at ambient temperature were recorded and presented in table 4. Out of total storage duration i.e. 0, 15, 30, 45 and 60 days, the microbial analysis was carried out after 15 days interval. No yeast and mold growth was detected up to analysis of 45 days for both the packaging material i.e. polythene pouches and aluminum pouches. At 90 days analysis the yeast and mold count observed for orange peel cookies packed in polythene and aluminum pouches were 19×10^5 and 76×10^5 (CFU/ g) respectively.

It was seen from Table 4 shows the ANOVA for the effect of packaging material and storage duration on yeast and mould count oforange peel cookies. It indicated that packaging treatments and storage duration had significant influence on yeast and mould count of orange peel cookies at $p\leq0.05$. The interaction also had significant influence on Yeast and mold count of orange peel cookies at $p\leq0.05$. The results were in general agreement with the results obtained by Nagi et al., (2012) cookies yeast and mold count range from 1.50×10^5 CFU/ g to 76×10^5 CFU/ g

Table 3. Effect of packaging material and storage duration of orange peel cookies on yeast and mold count

Duration	**Polythene Pouch**	**Aluminum Pouch**
0 Days	Not Detected	Not detected
15 Days	Not Detected	Not detected
30 Days	Not Detected	Not detected
45 Days	11×10^5 CFU/ g	10×10^5 CFU/ g
60 Days	18×10^5 CFU/ g	13×10^5 CFU/ g
75 Days	17×10^5 CFU/ g	23×10^5 CFU/ g
90 Days	29×10^5 CFU/ g	28×10^5 CFU/ g

	Packaging material (P)	**Storage Duration (S)**	**Interaction (P×S)**
SE	0.407	0.762	1.078
CD	NON SIG	NON SIG	NON SIG

Standard plate count count and yeast and mold count had shown increasing trend with extended storage. However, on storage at ambient temperature.The shelf life of orange peel cookies in polythene pouches and in aluminum pouches was recorded as 45 days respectively. The variation in the standard plate count and yeast and mould count of orange peel cookies stored at room temperature might be due to the packaging material used .Because the packaging material protect the contamination and growth of the SPC, number of microorganism and Yeast and Mould.

Sensory analysis:-

The average sensory score viz. colour, flavor, texture, and overall acceptability of orange peel cookies stored for 0, 15, 30, 45, 60 75 and 90 days as per the nine point hedonic scale determined by trained panel for two packaging treatment polythene pouches and aluminum pouches are presented in Table 2. Sensory analysis was conducted at 15 days interval.

The average colour scores for orange peel cookies stored in polythene pouches for 0, 15, 30, 45, 60 75 and 90 dayswas7.714, 8.107, 7.536, 7.464, 7.086, 7.000 and 7.014 and aluminum pouches for 7.764, 8.321, 7.657, 7.743, 7.464, 7.129 and 7.093 respectively. It can be seen from Table 5 (a) that ANOVA for the effect ofpackaging material and storage duration on colour of orange peel cookies. It indicated that packaging treatments had no significant influence on colour oforange peel cookies at $p\leq0.05$but storage duration had significant influence on

colour of orange peel cookies packed in both polythene pouches and aluminum pouches. The interaction also shows the no significant influence on colour oforange peel cookies at p≤0.05.The average flavour score for orange peel cookies stored in polythene pouches for 0, 15, 30, 45 and 60 days were 7.426, 7.607, 7.593, 6.993, 7.186, 66.371 and 6.836 and aluminum pouches7.386, 7.149, 7.800, 7.757, 7.514, 6.736, and 7.250 respectively. It was seen from Table 5 (b) shows the ANOVA for the effect of packaging material and storage duration on flavour oforange peel cookies. It indicated that packaging material and storage duration had significant influence on flavour oforange peel cookies at p≤0.05. The interaction shows nosignificant influence on flavour of orange peel cookiesat p≤0.05.

The average texture score for orange peel cookies stored in polythene pouches ranged between 7.579, 7.393, 7.293, 7.279, 7.086, 6.657 andaluminum pouches 6.643 and 7.729, 14.000, 15.000, 7.614, 7.307, 6.950 and 6.807. It was seen from Table 5 (c) shows the ANOVA for the effect of packaging material and storage duration on texture of orange peel cookies. It indicated that packaging material had no significant influence on texture of orange peel cookies at p≤0.05but the storage treatment shows the significant effect of the orange peel cookies. The interaction shows the no significant influence on texture oforange peel cookies at p≤0.05.

The average Taste score for orange peel cookies stored in polythene pouches ranged between 7.82, 7.37, 7.24, 7.02, 6.97, 6.78, and 6.64 and aluminum pouches 7.63, 14,7.73, 7.56, 7.32, 7.02 and 7.02 .It was seen from Table 5 (c) shows the ANOVA for the effect of packaging material and storage duration on taste of orange peel cookies. It indicated that packaging material had no significant influence on taste of orange peel cookies at p≤0.05 but the storage treatment shows the significant effect of the orange peel cookies. The interaction shows the no significant influence on taste of orange peel cookies at p≤0.05.

The average overall acceptability score for orange peel cookies stored in polythene pouches ranged between 8.071, 7.486, 7.307, 7.150, 7.236, 6.864 and 6.743 and aluminum pouches 8.057, 7.721, 7.493, 7.764, 7.514, 7.129 and 7.036. It was seen from Table 6 (d) shows the ANOVA for the effect of packaging material and storage duration on overall acceptability of orange peel cookies It indicated that packaging material and storage duration had significant influence on overall acceptability of orange peel cookies at p≤0.05. The interaction also showed the significant influence on overall acceptability of orange peel cookies at p≤0.05.

Table 5. Effect of packaging material and storage duration of orange peel cookies on sensory attribute and its ANOVA

Packaging material	Days						
	0	15	30	45	60	75	90
1. Sensory Analysis							
a. Colour							
Polythene	7.714	8.107	7.536	7.464	7.086	7.000	7.014
Aluminum	7.764	8.321	7.657	7.743	7.464	7.129	7.093
b. Flavour							
Polythene	7.429	7.607	7.593	6.993	7.186	6.371	6.836
Aluminum	7.386	7.914	7.800	7.757	7.514	6.736	7.250
c. Texture							
Polythene	7.576	7.393	7.293	7.279	7.086	6.657	6.643
Aluminum	7.729	14.000	15.000	7.614	7.307	6.950	6.807
d. Overall acceptability							
Polythene	8.071	7.486	7.307	7.150	7.236	6.864	6.743
Aluminum	8.071	7.721	7.493	7.764	7.514	7.129	7.036

It can be concluded that orange peel cookies were packed inn aluminium pouches hasrecived compared with polythene and overall acceptability 7.036 pouches i.e., 7.014, 6.836, 6.438 and 6.743 the highest score colour 7.093; flavor 7.250; texture 6.807

Table 2 Statistical Analysis of orange peel cookies packed packed in polythene and aluminum pouches.

(a) TSS								
Packaging Material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	49.166	45.111	41.555	36.900	31.935	26.468	22.111	36.178
Aluminum	49.755	46.644	43.277	37.777	34.744	29.322	25.455	38.136
Mean	49.461	45.877	42.416	37.339	33.340	27.895	23.783	37.159
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.164				0.471			
Storage Duration (S)	0.308				0.881			
Interaction (P×S)	0.436				1.260			
(b) Acidity								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	0.093	0.073	0.058	0.055	0.049	0.46	0.043	0.060
Aluminium	0.082	0.072	0.065	0.058	0.054	0.054	0.053	0.063
Mean	0.088	0.073	0.061	0.053	0.052	0.050	0.048	0.061
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.001				0.004			
Storage Duration (S)	0.003				0.009			
Interaction (P×S)	0.004				0.013			
(c) Reducing sugar								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	3.360	2.865	2.699	2.152	1.857	0.876	0.745	2.079
Aluminium	2.901	2.853	2.361	2.162	1.792	1.607	0.970	2.092
Mean	3.131	2.859	2.530	2.157	1.825	1.242	0.858	2.086
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.088				0.251			
Storage Duration (S)	0.164				0.471			
Interaction (P×S)	0.233				0.673			
(d) Non-reducing sugar								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	23.52	21.522	20.178	19.456	19.277	19.021	17.582	20.085
Aluminium	24.51	20.900	21.091	19.679	19.858	19.207	18.284	20.504
Mean	24.02	21.226	20.634	19.568	19.568	19.114	17.933	20.295
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.190				0.544			
Storage Duration (S)	0.356				1.017			
Interaction (P×S)	0.503				1.454			
(e) Total sugar								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	26.72	24.274	22.741	21.501	21.041	19.854	18.290	22.060

Aluminium	28.38	24.024	23.334	21.733	21.561	20.720	19.206	22.709
Mean	27.55	24.149	23.038	21.617	21.301	20.287	18.748	22.385
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.214				0.613			
Storage Duration (S)	0.401				1.148			
Interaction (P×S)	0.568				1.641			
(f) Ascorbic acid								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	48.03	40.950	37.450	31.897	27.313	22.403	17.710	32.251
Aluminium	47.73	44.113	40.563	37.853	34.040	30.173	25.273	37.108
Mean	48.88	42.532	39.007	34.875	30.677	26.288	21.492	34.680
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.151				0.433			
Storage Duration (S)	0.283				0.810			
Interaction (P×S)	0.400				1.157			
(g) Browning Index								
Packaging material	**0**	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Polythene	12.59	11.699	11.817	12.305	10.525	9.846	10.119	11.272
Aluminium	9.348	13.011	11.367	10.321	10.727	9.953	11.138	10.838
Mean	10.97	12.355	11.592	11.313	10.626	9.900	10.628	11.055
	S.Em ±				**CD at 5%**			
Packaging material (P)	0.184				0.527			
Storage Duration (S)	0.345				0.986			
Interaction (P×S)	0.488				1.409			

Conclusion:-

The cookies incorporated with 3% orange peel powder and backed at 190°C was selected for packaging and storage. 50 g of Orange peel cookies sample was filled separately in polythene and aluminum laminated pouches and sealed properly. These packets were kept at ambient temperature up to 12 weeks. The stored samples were analyzed at every 15 days interval up to 3 months. The observations for the TSS, acidity, reducing sugar, non-reducing sugar, total sugar, ascorbic acid , browning index, sensory attributes and microbial analysis of stored sample were taken during 0, 15, 30, 45, 60, 75 and 90 days. The TSS, acidity, reducing sugar, non-reducing sugar, total sugar, ascorbic acid , browning index, sensory attributes and microbial analyses for the stored sample were determined for each of the storage duration.

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