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**Research paper**

# Effect of different Pretreatments on Physic-chemical Properties of Cucumber Chips Fried in different Oils

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**ABSTRACT**

The objective of this study was to develop cucumber chips applying deep frying technique. The cucumber chips were deep-fried at 180°C for 13-44 sec. Physicochemical properties of the prepared chips, such as moisture content, ash content, pH, acidity, color (L*, a*, b*), and whitening index. Colors of fried in mustard oil, sunflower oil, groundnut oil and canola oil cucumber chips blackness to lightness, green to red and blue to yellow range of L* (25.38-75.46), a* (-7.14 to + 13.79) b* (7.15- 30.66). The whiteness index of the cucumber chips was range of (16.60-69.50). The maximum sensory acceptability of cucumber chips fried at 180 °C in mustard oil, sunflower oil, groundnut oil, and canola oil to consumer panelists was T4.

**Keywords:** Cucumber chips, frying, physicochemical, color, whiteness index

Deep frying is one of the most common methods used for the preparation of food. Repeated frying causes several oxidative and thermal reactions which results in change in the physico-chemical, nutritional and sensory properties of the oil (Che Man and Jasvir, 2000). Deep-fat frying is one of the best cooking techniques to make palatable foods with golden color, savory flavor, and desirable texture through a complete immersion of food materials in a frying oil. During frying, heat is transferred from oil to food materials, and water in fried products evaporates simultaneously with the products absorbing the oil (Nayak *et al.* 2016). Vegetable oils are considered as an ideal cooking medium due to their health beneficial effects. Although exposure to oxygen, heat, and light enhance the oil deterioration and reduce the nutritional value of oil (Naz *et al.* 2005).

Fruits and vegetables are usually subjected to physical or chemical pretreatment before drying to shorten the drying time, reduce the energy consumption and preserve the quality of products (Yu *et al.* 2017). Hot water blanching is a common pretreatment used prior to drying, it involves to immerse fresh products into hot water at a constant temperature ranging from 70 to 100 °C for several minutes (Guida *et al.* 2013).

The effect of the drying process on vegetable quality was evaluated by different authors on products such as sea cucumber (Duan *et al.* 2007). The quality of fried foods depends not only on the type of foods and frying conditions, but also on the oil used for frying.

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Thus, the selection of stable frying oils of good quality is of great importance to maintain a low deterioration during frying and consequently a high quality of the fried foods (Stevenson *et al.* 1984). The oil must be able to withstand high temperatures and have high enough stability to be reusable. Furthermore, the oil needs to maintain a high oxidative stability during the shelf life of the product. Different types of oils can be used for frying. The chemical composition of frying oil and its physical properties has an influence both on the frying process and on the stability characteristic of oil against oxidation and decomposition. Therefore, the importance of the correct selection of the oil for frying is one of the most considerable issues (Rossi *et al.* 2007). During frying the oil rapidly changes from a light yellow to an orange brown color. This is the combined result of oxidation, polymerization and other chemical changes which also result in an increase in viscosity of the frying oil (Medeni, 2003).

## MATERIALS AND METHODS

Fresh cucumber belongs to the cucurbitaceous family devoid of any visible microbial infection or mechanical fissures, mustard oil, sunflower oil, groundnut oil, and canola oil were procured from the local market of Modipuram Meerut (U.P) India. Cucumbers were washed with tap water to remove dust and dirt from the surface. The samples were then peeled, washed with water, and sliced with a chips cutter. Chips were then pretreated and weight was recorded before and after each pretreatment.

### 1. Preparation of cucumber Chips

Development of cucumber chips and their frying and quality evaluation were performed in the laboratory at the College of Post Harvest Technology and Food Processing, S.V.P. University of Agriculture and Technology, Meerut. Studies have also been carried out to evaluate the physico-chemical properties of cucumber chips, fried in different oils.

Cucumber chips were prepared as the Fig. 1.

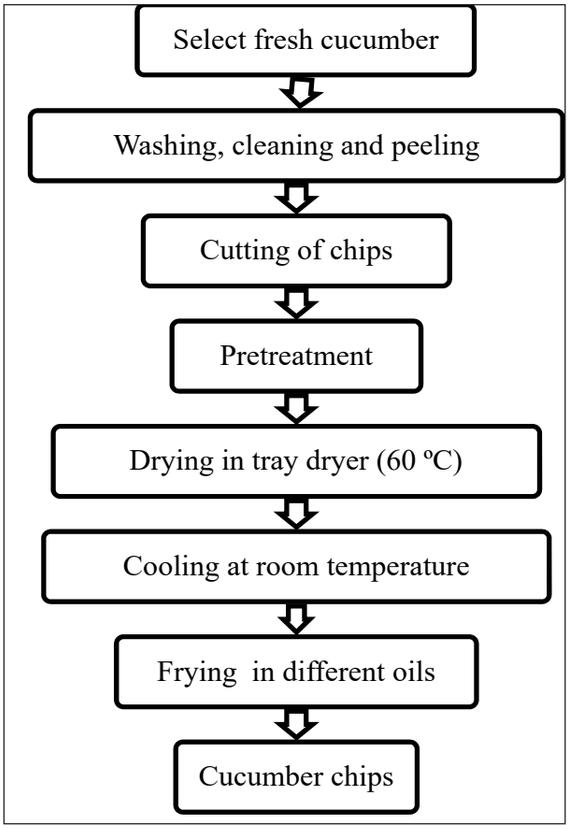


**Fig. 1:** Flow chart for cucumber chips development

### 2. Pretreatments

Pretreatments were applied to the cucumber slices, and an untreated sample was used as a control. The slices were subjected to pre-treatments indicated as follow:

T1: Blanching with 90°C for 5 min,

T2: Blanching with 1% Nacl at 90°C for 5 min

T3: Blanching with 0.5% KMS + 1.0 % NaCl at 90°C for 5 min.

T4: Blanching with 0.5% KMS + 1% NaCl, + 0.5% CA at 90 °C for 5 min.

T5: Blanching with 1%$Cacl_2$+1% NaCl at 90 °C for 5 min.

The slices were then removed from the solution, the surface moisture was removed using blotting paper,

and then spread in trays subjected to drying in a tray dryer at 60 °C.

**3. Moisture Content**

Moisture content % (w.b.) of fresh samples was obtained using the standard (AOAC, 1990).

**4. pH**

A digital pH meter (Systronics μ pH system, 361) was used to determine the pH of the samples.

**5. Acidity**

Acidity of various samples was determined by using the method as recommended by (Ranganna, 2001).

**6. Ash content**

The **(AOAC, 2000)** method with a muffle furnace (TANCO model) was used to determine the ash contents of the samples.

**7. Color value**

Lightness (L*), redness (a*), and yellowness (b*) values of the slices were measured. L*, a*, and b* were measured using a colour meter (3Nh color meter, China) after calibration with a white standard plate.

**8. Whiteness index**

Whiteness is the measured amount of light reflected by a support through the visible light spectrum. This value is obtained by calculating the amount of light *White* -that is, the sum of reflected wavelengths of the spectrum- that the surface manifests. Thus, the value is useful in determining how *white* is a support to the human eye. The measurement of whiteness is expressed as a percentage, on a scale of 1-100%, with 100% being the value that should correspond to a *perfect white*.

**9. Sensory Evaluation**

Sensory evaluation indicates the acceptability of the product. Acceptability of chips was judged, on a nine point hedonic scale. The sensory evaluation carried out on the basis of color, texture, taste, crispiness and overall acceptability of the developed product. The sensory evaluation of the treatments for the organoleptic qualities (Ranganna, 1995).

## RESULTS AND DISCUSSION

**1. Moisture content**

The acceptable range of moisture content for cucumber chips before they were fried in oil is shown in Table 1 as 96.01 percent water by weight (% w.b.). Treatment T5 had the highest moisture content (96.01) percent water by weight (% w.b.) and T2 had the lowest moisture content (95.22) percent water by weight (% w.b.). The results showed that treatment T5, which did receive $CaCl_2$ chemical treatment, had the highest moisture content, whereas T3, which received KMS and NaCl chemical treatment had the lowest moisture content. Following frying in mustard oil of cucumber chips (table 2) 2.69 to 3.65 percent water by weight. Treatment T5 had the lowest moisture content (2.69% w. b.) and T1 had the highest (3.65 % w. b.).The results were highest in treatment T1 due to the without any chemical effects the lowest moisture content in T5 due to the effects of $CaCl_2$ reducing moisture content. The cucumber chips were fried in sunflower oil, and the results are shown in Table 3 under moisture content. After being fried in sunflower oil, the cucumber chips had a moisture level that ranged from 1.38 to 2.78 % w .b. Treatment T5 had the highest moisture content (2.78 % w. b.) and Treatment T2 had the lowest moisture content (1.38 % w. b.). The moisture content of treatment T2 was the lowest due to the effects of frying the cucumber chips in sunflower oil and the NaCl of chemical treatment, while treatment T5's moisture content was the highest due to the treatment $CaCl_2$. After being fried in groundnut oil, the moisture content ranged from 2.07 to 2.76 % (Table 4). Treatment T5 had the highest moisture content (2.76 % w. b.) and Treatment T3 had the lowest moisture content (2.07 % w. b.).The results showed that treatment T5 had the maximum moisture content after being fried in groundnut oil, while treatment T2 had the lowest. Table 5 displays the results for the deep-fried cucumber chips in canola oil. The range of moisture

content was determined 1.94 to 4.76 % w. b. T5 had the highest moisture content (4.76 % w. b.), whereas T4 had the lowest (1.94 % w. b.). Following the canola oil frying of the cucumber chips, the outcome revealed that treatment T5 had the greatest effect. It is among the best treatment of cucumber chips fried in different vegetable oil.

**2. Ash content**

The ash content range of cucumber chips (4.06-7.87%) before frying is displayed in Table 1. The treatment with the highest ash content was T5 (7.87%), whereas the lowest ash content was T3 (4.06%). Treatment T3 had the lowest amount of ash, because there was KMS and NaCl chemical treatment. The results of mustard oil frying of cucumber chips are displayed in Table 2 cucumber chips with an ash percentage between (1.65-8.23 %) after being fried in mustard oil. Treatment T5 had the highest ash content (8.23%), while Treatment T1 had the lowest ash content (1.65 %). The highest ash content was the outcome of the treatment T5's effect on cucumber chips after they had been fried in mustard oil. Cucumber chips after being fried in sunflower oil. In table 3, the outcome was displayed. Cucumber chips may include between (1.51-6.54 %) ash content. Treatment T1 had the lowest amount of ash content (1.51 %), and Treatment T5 had the highest amount (6.54 %). The outcome was maximum ash concentration in treatment T5 and the effect of frying in sunflower oil because treatment T5 had a greater effect. The ash content range of cucumber chips (2.93-6.90 %) after frying in groundnut oil displayed in Table 4. T5 had the highest ash content (6.90%), whereas T1 had the lowest ash content (2.93%). Treatment T5 had a greater impact as a result of the groundnut oil used to fry cucumber chips. The range of the ash content of cucumber chips that had been fried in canola oil is displayed in Table 5 (1.94-8.35%). Treatment T5 had the highest ash content (8.35%), and treatment T1 had the lowest ash content (1.94%). As the cucumber chips were fried in canola oil, treatment T1 had a lower effect, whereas treatment T5 had a higher effect.

**pH**

The pH range values before fried of the cucumber chips are shown in Table 1 (6.34-7.36). The pH value of the cucumber chips in treatment T1 was the highest (7.36), whereas treatment T4 had the lowest pH value (6.36). The outcome showed that treatment T4 had more of an impact than treatment T1. The range of cucumber chips in Table 2 after they were fried in mustard oil (6.44-6.87).

The highest pH value was found in T2 (6.87) and lowest pH value in treatment T5 (6.44). $CaCl_2$ was more effect of pH in T5 and less effect of NaCl in T2. The pH readings of the results are shown in Table 3. The pH range values of the cucumber chips in Table 3, (3.98-5.50). Cucumber chips compressed for cooking in mustard and sunflower oils. In comparison to

**Table 1:** Moisture content, ash content, pH, color characteristics and whiteness index of different cucumber chips samples before frying

| Treatment | M.C. | A.C. | pH | Acidity | Color | | | W.I. |
|---|---|---|---|---|---|---|---|---|
| | | | | | L* | a* | b* | |
| T1 | 91.25±0.15 | 4.34±0.01 | 7.36±0.01 | 0.05±0.01 | 40.00 | -5.07 | 12.69 | 29.70 |
| T2 | 95.22±0.06 | 4.50±0.02 | 7.32±0.02 | 0.06±0.00 | 39.19 | -4.80 | 10.96 | 31.30 |
| T3 | 95.87±0.13 | 4.06±0.00 | 7.03±0.02 | 0.09±0.01 | 75.46 | -3.50 | 13.97 | 40.10 |
| T4 | 95.81±0.10 | 5.36±0.38 | 6.36±0.00 | 0.10±0.01 | 67.04 | -6.44 | 14.71 | 29.70 |
| T5 | 96.01±0.02 | 7.87±0.43 | 6.59±0.00 | 0.07±0.00 | 61.09 | -7.14 | 17.02 | 22.00 |

**M.C.: Moisture content, *A.C.: Ash content, *W.I.: Whiteness index ±: Standard deviation.*

**Table 2:** Moisture content, ash content, pH, color and whiteness index of the different cucumber chips samples after frying in mustard oil

| Treatment | M.C. | A.C. | pH | Acidity | Color | | | W.I. |
|---|---|---|---|---|---|---|---|---|
| | | | | | L* | a* | b* | |
| T1 | 3.65±0.06 | 1.65±0.00 | 6.45±0.02 | 0.07±0.01 | 46.53 | -1.57 | 14.05 | 50.50 |
| T2 | 2.72±0.11 | 4.68±0.14 | 6.87±0.00 | 0.09±0.01 | 29.16 | 0.44 | 8.43 | 47.30 |
| T3 | 2.85±0.10 | 2.78±0.01 | 6.49±0.02 | 0.08±0.00 | 27.43 | 4.64 | 10.63 | 69.50 |
| T4 | 2.96±0.08 | 4.69±0.03 | 6.57±0.01 | 0.12±0.02 | 38.01 | 1.18 | 12.74 | 37.90 |
| T5 | 2.69±0.08 | 8.23±0.11 | 6.44±0.01 | 0.09±0.00 | 33.19 | -1.19 | 7.15 | 55.10 |

**M.C.: Moisture content, *A.C.: Ash content, *W.I.: Whiteness index ±: Standard deviation.*

**Table 3:** Moisture content, ash content, pH, color and whiteness index of the different cucumber chips samples after frying in sunflower oil

| Treatment | M.C. | A.C. | pH | Acidity | Color | | | W.I. |
|---|---|---|---|---|---|---|---|---|
| | | | | | L* | a* | b* | |
| T1 | 1.84±0.02 | 1.51±0.00 | 3.98±0.01 | 0.07±0.02 | 32.45 | 3.50 | 13.65 | 21.70 |
| T2 | 1.38±0.02 | 3.92±0.01 | 5.50±0.02 | 0.08±0.01 | 27.86 | 3.01 | 11.84 | 16.60 |
| T3 | 1.39±0.04 | 2.16±0.05 | 4.81±0.00 | 0.07±0.01 | 29.32 | 7.70 | 15.46 | 35.60 |
| T4 | 2.15±0.03 | 3.34±0.04 | 4.98±0.00 | 0.11±0.01 | 37.21 | 2.91 | 16.81 | 22.60 |
| T5 | 2.78±0.02 | 6.54±0.05 | 4.31±0.01 | 0.12±0.01 | 46.06 | 0.57 | 15.13 | 21.70 |

**M.C.: Moisture content, *A.C.: Ash content, *W.I.: Whiteness index ±: Standard deviation.*

mustard oil, all treatments of the potato chips fried in sunflower oil had low pH. As a result, cucumber chips fried in sunflower oil will be more acidic. The results are displayed in Table 4. The pH range of cucumber chips (5.31-7.27) after being fried in groundnut oil. T5 had the lowest pH (5.31) and T2 had the highest pH (7.27) value. The effect of $CaCl_2$ and frying cucumber chips in groundnut oil led to the greatest acidity value to emerge in treatment T2. The pH results for the cucumber chips that had been fried in canola oil are displayed in Table 5. The pH range (5.14-6.84) of cucumber chips after they were fried in canola oil. The treatment T2 yielded the greatest pH value of cucumber chips fried in canola oil (6.84) and the lowest pH value of T1 (5.14).The T1 treatment had a very high acidic pH value. Treatment had an impact, as canola oil used to fry of cucumber chips. When compared to before frying and after fried of cucumber chips, there was decrease pH in the fried oil.

**4. Acidity**

Prior to being fried in oil, the acidity of cucumber chips ranged from (0.05–0.10) in Table 1. T4 (0.10) and T1 (0.05) had the highest and lowest acidities, respectively. The treatment with the highest acidity level was T4, which was a consequence of the combined action of citric acid, potassium per magnate and sodium chlorides. Table 2 lists the range of acidity values (0.07-0.12) for fries of cucumber chips made using mustard oil. The acidic value for treatment T4 was 0.12, whereas that for treatment T1 was 0.07. The results showed that treatment T1 lowered the acidity of cucumber chips when they were compressed without being fried, whereas another type of treatment caused it to increase when the chips were cooked in mustard oil. The acidity range of cucumber chips after being fried in sunflower oil is presented in Table 3. Treatment T1 and T3 had the lowest acidity (0.07), whereas Treatment T5 had the highest

**Table 4:** Moisture content, ash content, pH, color and whiteness index of the different cucumber chips samples after frying in groundnut oil

| Treatment | M.C. | A.C. | pH | Acidity | Color | | | W.I. |
|---|---|---|---|---|---|---|---|---|
| | | | | | L* | a* | b* | |
| T1 | 2.43±0.05 | 2.93±0.00 | 5.50±0.01 | 0.15±0.03 | 27.48 | 9.36 | 16.02 | 28.30 |
| T2 | 2.26±0.02 | 4.50±0.10 | 7.27±0.03 | 0.09±0.01 | 44.89 | 13.79 | 30.66 | 33.30 |
| T3 | 2.07±0.01 | 4.31±0.02 | 5.39±0.02 | 0.14±0.00 | 25.38 | 7.06 | 11.90 | 58.40 |
| T4 | 2.61±0.10 | 4.34±0.01 | 6.69±0.01 | 0.07±0.00 | 36.24 | 9.36 | 26.01 | 32.50 |
| T5 | 2.76±0.02 | 6.90±0.07 | 5.31±0.01 | 0.12±0.02 | 39.76 | 11.32 | 24.50 | 26.40 |

**M.C.: Moisture content, *A.C.: Ash content, *W.I.: Whiteness index ±: Standard deviation.*

acidity (0.12). The results of treatment T5 showed that frying sunflower oil and using $CaCl_2$+ NaCl had an effect, after preparation in groundnut oil Table 4. Acidity range of groundnut oil-fried cucumber chips (0.07–0.14). After being fried in groundnut oil, treatment T3 had the highest acidity (0.14), whereas treatment T4 had the lowest acidity (0.07). the acidity of cucumber chips cooked in groundnut oil increased when compared to those cooked in sunflower oil and mustard oil. Cucumber chips that have been deep-fried in canola oil have an acidity range of (0.06-0.12) shown in Table 5. The T2 and T4 treatments exhibited the lowest and T1 highest acidic values, respectively, after being fried in canola oil. Treatment T2 and T4 acidic value was 0.06 and that of treatment T1 was 0.12. The acidity of cucumber chips fried in canola oil increased in treatments T2, T3, T4 and T5.

**5. Color**

Three factors, L* (lightness-darkness), a* (red-green), and b* (yellow-blue), determine the color. The L* color value range (39.19-75.46) before they were fried in oil. T3 had the highest L* color value (75.46), and T2 had the lowest L* color value (39.19). The results are provided in Table 1, together with the maximum and lowest brightness color values for treatment T3 and T2 of cucumber chips.

Before being fried in oil, a* and b* values ranged from (-7.14 to -3.50) and (10.96-17.02), respectively. The highest a* and b* values were found in treatments T3 (-3.50) and T5 (17.02), whereas treatment T5 had the lowest a* value (-7.14) and b* value (10.96). The outcome was a higher value for red color and a lower value for green color, making treatment T5 more greenish in color and treatment T3 less red. The results of b* value if + yellow color and - value blue color are given in Table 1, with greater yellow color in treatment T5 and less yellow color in treatment T2. Table 2 shows the range of color values for L*, a*, and b* after frying cucumber chips in mustard oil: L* value (27.43-46.53), a* (-1.57 to 4.64), and b* (07.15-14.05). Treatments T1 (46.53), T3 (4.64), and T1 (14.05) had the highest L*, a*, and b* values. After the cucumber chips were fried in mustard oil, treatment T1 had a more lighter color, and treatment T3 had a less lighter color. For a*, treatment T1 exhibited a greater degree of greenish color, but treatment T3 exhibited a much lower degree of redness color. The more yellow color in treatment T1 and the lowest yellow color in treatment T5 were identified in the analysis of the b* value, which was set to determine the highest value. Table 3 shows the color values of L*, a*, and b* in the cucumber chip ranges (27.86-46.06), (0.57- 7.70), and (11.84-16.81) after being fried in sunflower oil. Highest L* values for treatments T5 and lowest T2 were 46.06 and 27.86, respectively. Following cucumber chip frying in sunflower oil, the results showed that T5 produced lighter chips than T2, and vice versa. Treatment T3 and T4 had the highest a* and b* values (7.70) and (16.81), whereas treatment T5 and T2 had the lowest values (0.57) and (11.84), respectively. The outcome was that after being fried in sunflower oil, cucumber chips treated with T5 had a greenish hue, and T3 had a more red hue. Treatment T4 had a stronger yellowish color

in the b* value of the outcome, whereas Treatment T2 had a less yellowish color. Table 4 displays the range of color values L*, a*, and b* for groundnut oil-fried cucumber chips (25.38-44.89), (7.06 -13.79), and (11.90-30.66). After being fried in groundnut oil, cucumber chips in T2 had the highest L* value (44.89) and lowest L* value (25.38) in T3. After being fried in groundnut oil, cucumber chips had a lower color value and higher lightness in T2. The lowest a* and b* values of T3 (7.06) and (11.90), respectively. Highest a* and b* values of cucumber chips after being fried in groundnut oil was T2 (13.79) and (30.66), respectively. a* and b* appeared less redness and yellowish in T3 and more redness and yellowness in T2 respectively. Table 5 shows the L*, a*, and b* color value ranges for cucumber chips that have been fried in canola oil, which are (38.84-52.03), (0.07-8.62), and (6.40-27.61). The highest L*, a*, and b* values were in treatment T5 (52.03), T4 (8.62), andT5 (27.61), while the lowest values were in treatment T3 (38.84), T2 (0.07), and T2 (6.40). As a result, treatment T5's color became lighter, treatment T2's color turned less greener, and treatment T5's color turned yellow. There were more changes in the color value after frying than previously, but the quality of the cucumber chips remained suitable for consumer demand. All varieties of frying oils used for cucumber chips were found to be effective. Treatment T5, which was deep-fried in canola oil, had the lightest color. Cucumber chips without frying in oils, T5 showed the highest percentage of greenish color, following the frying of cucumber chips in mustard oil, sunflower oil, groundnut oil and canola oil. The color of fried potatoes is usually measured usually in the unit of L* a*b*, using either a colorimeter or specific image-acquisition and processing systems. Parameter L* is the luminance or lightness component, which ranges from 0 to 100, and parameters a* (from green to red) and b* (from blue to yellow) are the two chromatic components, which range from -120 to 120 (Papadakis *et al.* 2000).

**6. Whiteness index**

Table 1 shows the (22.00-40.10) range of the whiteness index of cucumber chips prior to cooking in oil. The treatment T3 had the highest whiteness index (40.10), and the T5 treatment had the lowest whiteness index (22.00). The range of the whiteness index for the cucumber chips in table 2 after they had been fried in mustard oil was (37.90-69.50). The results showed that Treatment T3 had the highest whiteness index (69.50), while treatment T4 had the lowest whiteness index (37.90). When cucumber chips were compressed before and after being fried in mustard oil, the whiteness index increased (T1-T5). The whiteness scores of the fried sunflower oil cucumber chips in Table 3 are indicated. (16.60–35.60) was within the range of the whiteness index. T2 had the lowest whiteness index (16.60), whereas T3 had the highest whiteness index (35.60). The results showed that frying cucumber chips with mustard oil, sunflower oil, or compression treatments (T1-T5) decreased the whiteness index. After being fried in groundnut oil, the cucumber chips in table 4 had a

**Table 5:** Moisture content, ash content, pH, color and whiteness index of the different cucumber chips samples after frying in canola oil

| Treatment | M.C. | A.C. | pH | Acidity | Color | | | W.I. |
|---|---|---|---|---|---|---|---|---|
| | | | | | L* | a* | b* | |
| T1 | 3.42±0.03 | 1.94±0.04 | 5.14±0.00 | 0.12±0.02 | 46.06 | 0.57 | 15.13 | 34.60 |
| T2 | 2.84±0.05 | 4.19±0.02 | 6.84±0.01 | 0.06±0.00 | 41.60 | 0.07 | 6.40 | 38.30 |
| T3 | 3.45±0.10 | 3.25±0.05 | 5.38±0.04 | 0.10±0.00 | 38.84 | 4.68 | 16.95 | 18.70 |
| T4 | 1.94±0.02 | 4.56±0.03 | 6.80±0.01 | 0.06±0.00 | 44.85 | 8.62 | 26.03 | 24.60 |
| T5 | 4.76±0.06 | 8.35±0.05 | 5.32±0.03 | 0.10±0.01 | 52.03 | 7.91 | 27.61 | 35.10 |

**M.C.: Moisture content, *A.C.: Ash content, *W.I.: Whiteness index ±: Standard deviation.*

whiteness index ranging from (26.40-58.40). T3 had the highest whiteness index (58.40), whereas T5 had the lowest (26.40). The outcome was that when cucumber chips were fried in groundnut oil, the whiteness index increased for treatments (T1-T5) when compared to fried sunflower oil. The whiteness index of canola oil-fried cucumber chips (18.70–38.30) is illustrated in Table 5. Treatment T2 had the highest whiteness index (38.30), whereas treatment T3 had the lowest (18.70). Decreases in the whiteness index for treatments T3 and T4 and increases for T1, T2 and T5 in comparison to cucumber chips fried in groundnut oil.

**7. Sensory Evaluation**

The Consumer preference for deep-fried cucumber chips was determined by sensory analysis. The color, texture, taste, crispiness, and overall acceptability of the cucumber chips were evaluated for sensory acceptance. For color, texture, taste, crispiness, and overall quality for the sample fried at 180°C for a brief period of time, the panelists preferred the vacuum-fried cucumber chips above mustard oil, sunflower oil, groundnut oil, and canola oil.

The panelists' total acceptance scores are presented in Tables 6 and 7. According to the sensory evaluation findings, the majority of panelists regarded the color of cucumber chips as a premium characteristic. The process temperature had a significant impact on the sensory evaluation of cucumber chips (0.05). When frying at a higher temperature of 180 °C, the sensory scores for the color of the cucumber chips were (7.12-8.50), (6.25-7.62), (6.25-7.50), and (6.00-7.50), respectively. The results of the panelists' sensory evaluations are presented. This could be a result of less color deterioration caused by deep frying Maillard reactions and oxidation. On a 9-point hedonic sensory scale, treatment T4 (8.12) had the highest sensory score for texture when it came to cucumber chips that were fried in mustard oil at 180°C, as opposed to treatments T4 (7.25), T5 (6.87), and T4 (7.12), which were cooked in sunflower oil, groundnut oil and canola oil. The T4 treatment had the highest taste rating (7.25) after frying potato chips

**Table 6:** Sensory evaluation of cucumber chips after frying in mustard oil and sunflower oil for different treatment

| Treatment | Mustard oil | | | | | Sunflower oil | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Color | Texture | Taste | Crispiness | Overall Acceptability | Color | Texture | Taste | Crispiness | Overall Acceptability |
| T1 | 7.12 | 7.00 | 7.12 | 6.75 | 6.99±0.15 | 6.25 | 6.50 | 6.12 | 6.37 | 6.31±0.14 |
| T2 | 7.50 | 7.12 | 6.62 | 7.00 | 7.06±0.31 | 7.00 | 7.12 | 6.62 | 6.50 | 6.81±0.25 |
| T3 | 8.00 | 7.50 | 7.00 | 7.12 | 7.40±0.38 | 6.87 | 6.62 | 7.00 | 6.25 | 6.68±0.28 |
| T4 | 8.50 | 8.12 | 7.25 | 7.62 | 7.87±0.47 | 7.62 | 7.25 | 7.25 | 7.50 | 7.40±0.16 |
| T5 | 7.37 | 6.75 | 6.87 | 6.50 | 6.87±0.31 | 6.37 | 6.75 | 6.25 | 6.12 | 6.37±0.23 |

**Table 7:** Sensory evaluation of cucumber chips after frying in Groundnut oil and Canola oil for different treatment

| Treatment | Groundnut oil | | | | | Canola oil | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Color | Texture | Taste | Crispiness | Overall Acceptability | Color | Texture | Taste | Crispiness | Overall Acceptability |
| T1 | 6.75 | 6.50 | 6.37 | 6.25 | 6.46±0.18 | 6.50 | 6.25 | 6.37 | 6.12 | 6.31±0.14 |
| T2 | 6.25 | 6.37 | 6.50 | 6.12 | 6.31±0.14 | 6.25 | 7.00 | 6.50 | 7.12 | 6.71±0.35 |
| T3 | 6.62 | 6.75 | 6.25 | 6.37 | 6.49±0.19 | 6.00 | 6.50 | 6.25 | 6.37 | 6.28±0.18 |
| T4 | 7.50 | 6.50 | 6.62 | 6.25 | 6.71±0.47 | 7.50 | 7.12 | 6.62 | 7.50 | 7.18±0.36 |
| T5 | 6.37 | 6.87 | 6.25 | 6.12 | 6.40±0.28 | 6.37 | 6.12 | 6.25 | 6.87 | 6.40±0.28 |

in mustard oil and sunflower oil, and treatments T1 had the lowest taste rating (6.12) after frying in sunflower oil, as shown in Tables 6. The T4 treatment of cucumber chips received the highest score for crispiness (7.62) and the T5 treatment received the lowest score (6.12) after being fried in groundnut oil and sunflower oil in T1 for canola oil. Crispiness is an important textural attribute that determines chip quality (Krokoda *et al.* 2001). The findings of the sensory evaluation indicated that treatment T4 (7.87) after fried in mustard oil was used to fry the cucumber chips had the highest overall acceptance, whereas treatment T3 had lowest (6.28) after fried in canola oil.

## CONCLUSION

In conclusion, moisture was lost from cucumber chips before and after they were fried in mustard, sunflower, groundnut, and canola oils. The more effect of the treatment T5, which did receive $CaCl_2$ chemical treatment, had the highest moisture content, whereas T3, which received KMS and NaCl chemical treatment, had the lowest moisture content. The outcome was maximum ash concentration in treatment T5 and the effect of frying in sunflower oil because treatment T5 had a greater effect. When compared to before frying and after fried of cucumber chips, there was decrease pH in the fried oil. The treatment with the highest acidity level was T4, which was a consequence of the combined action of citric acid, potassium per magnate and sodium chlorides. . Cucumber chips without frying in oils, T5 showed the highest percentage of greenish color, following the frying of cucumber chips in mustard oil, sunflower oil, groundnut oil and canola oil. When cucumber chips were compressed before and after being fried in mustard oil, the whiteness index increased (T1-T5). The outcome was that when cucumber chips were fried in groundnut oil, the whiteness index increased for treatments (T1-T5) when compared to fried sunflower oil. The color, texture, taste, crispiness, and overall acceptability of the cucumber chips were evaluated for sensory acceptance in T4 treatment fried in mustard oil.

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