A study of Chemical Composition and determination of acrylamide in fried potato chips

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Abstract. This study was designed to investigate the chemical composition and estimation of acrylamide in fresh and fried potato chips for the models under study. This study was conducted at the Food Science Laboratories, college of Agriculture, Tikrit University, Iraq. After selecting the potato class used in this research, deep frying was carried out at different temperatures (100, 130, 150, 170, 180), and the time period for frying was (4) minutes. After the process of deep frying of the samples was completed, several analyzes processes were conducted to determine the causes of the formation of acrylamide and the factors affecting it. Potato samples were analyzed for the chemical composition before and after the frying process of the potato chips. The moisture content was measured by a drying oven, and the protein content was measured by Kjeldahl method, the fat content was measured by the speculate method, sugar and ash. The chemical composition of the fresh potato was found to be 76.3%, 0.2%, 2.7%, 1% and 19.8%). The results of the chemical composition of fried potato chips found that the highest humidity at 100 °C for 4 minutes was 53.2% and the lowest moisture content was 10.12% at 180 °C for the same period. The highest fat content was 34.04% at 180 °C and the lowest fat content was 18.03%. The highest protein was at 130 °C and 1.50%. The highest ash was at 180 °C and was 3.11% for 4 minutes. As for sugars, the highest percentage was 51.79% when treated 180 °C for the same period. As for the estimation of acrylamide in the samples of this study, acrylamide was extracted with water (because it has high water solubility) and alcohol. Results showed that the formation of acrylamide in fresh potato chips was 5 mg / kg at a time of 4 minutes. As for the formation of acrylamide in fried potato chips at the same period and at different temperatures (100, 130, 150, 170, 180 °C), the highest ratio of acrylamide was 2416 μg / kg at 180 °C compared to the lowest of 136 μg / Kg at 100 °C and for the same duration of 4 minutes.

Keywords: fried potato chips, acrylamide, Chemical Composition
Introduction

Potato belongs to the family: Solanaceae and is one of the most important urban crops in a large number of countries of the world and due to their availability and cheap costs of production and diversity of environmental conditions that grow.

Potatoes are the fourth largest food producer in the world after wheat, maize and rice are important for human consumption in developed countries (1).

When the potatoes expose to the cooking process of frying, it will exposed to many changes in taste, color and flavor, and some of these changes are desirable and some are undesirable. Among the compounds formed during the process of frying, which are undesirable is the compound or acrylamide and other compounds formed by the method of cooking used, Swedish researchers have discovered the presence of carcinogens in many of these foods, especially cooked deep fried and grilled cooking, raising concern around the world (2).

Acrylamide (2-propenamide) A white crystalline chemical used in the manufacture of polyacrylamide used for water purification, cosmetics, paper making and others (3).

Acrylamide is found in cigarette smoke. This compound is also formed in starchy foods during cooking in high temperatures such as frying, baking and roasting (4).

Material of Methods

Using materials:

- Potatoes used in the research were obtained from the local markets of the city of Tikrit in the Republic of Iraq and were of the class Salanum Tuberosum L.
- Oil used in deep frying: Corn oil was used in the local market for deep frying of potato chips.
- Preparation of potato chips: Potato chips were prepared according to the common method in the processing factory (the traditional method), which included washing and cleaning the potatoes well using clean water and then the process of peeling using the peeler and then cut the potatoes into slices at thickness (1.5 - 2) mm using a cutting machine for potato chips and then wash the chips thoroughly with water and leave to dry for a few minutes. The deep frying of the potato chips was then carried out using the temperature regulator and the time delay.
- Frying Process: The frying process is the laying of potato chips for frying in a buckle made of stainless steel (which is part of the pot itself) and put the clamp in the pot containing enough oil. The temperature of the oil is controlled by the heat regulator and the timer which is regulated according to the desire. After placing the chips, the pot is closed tightly and at the end of the time required for the frying, the clamp is extracted and cooled slightly so that the potato chips are ready. After processing the potato chips, the deep frying process was carried out using different temperatures and a fixed time period to determine the temperatures at which the highest percentage of acrylamide is expected. The proposed temperatures in the deep frying process were 100, 130, 150, 170, and 180, for 4 minutes.
Chemical tests:
The following chemical tests were carried out on the potato chips and after the deep frying process:

1. **Determination of the percentage of moisture.**
The percentage of moisture was estimated according to method (44-11) mentioned in (5)

2. **Determination of protein percentage**
The total nitrogen ratio in the potato chips was estimated according to the method semimicro Kildalhe (46-11) mentioned in (A.A.C.C, 1976), and then multiplied the results by the protein factor which is (6.25) to extract the percentage of the protein.

3. **Fat determination**
The percentage of fat in potato chips was estimated according to method (7.048) mentioned in (5) using soxhlet extraction and using Petroleum ether as organic solvent.

4. **Ash Determination**
The ratio of ash in potato chips was calculated according to method (08-10) mentioned in (5).

5. **Carbohydrate Determination**
Carbohydrate ratio was estimated by subtracting total ingredients from 100 as mentioned in (5)

6. **Acrylamide Determination**
The GB-T5009 method was used to estimate acrylamide in food, a technique used in GC / MS, which showed 7 mg / kg, where acrylamide was extracted with polar solvents such as water and alcohol and a cleaned up process by centrifuge filtration.

**Results and discussion:**
Table (1) Chemical composition of potato chips before and after deep frying

| Treatments ° | Frying time/min. | Humidity % | Fat % | Proteins % | Ash % | Sugars % |
|--------------|------------------|------------|-------|------------|-------|----------|
| Fresh        | -                | 76.3       | 0.2   | 2.7        | 1.0   | 19.8     |
| 100          | 4                | 53.2       | 18.03 | 1.16       | 2.93  | 24.68    |
| 130          | 4                | 29.82      | 21.32 | 1.50       | 2.10  | 45.26    |
| 150          | 4                | 26.43      | 28.12 | 1.19       | 1.38  | 42.88    |
| 170          | 4                | 23.21      | 31.20 | 1.04       | 2.91  | 41.64    |
| 180          | 4                | 10.12      | 34.04 | 0.94       | 3.11  | 51.79    |
Chemical composition:-
Table 4.1 shows the chemical composition of raw potato chips before and after deep frying. Moisture was found in the raw potato chips before deep frying. The percentage of moisture in potato chips was 76.3%, the fat content was 0.2%, the protein was 2.7%, the ash was 1.0%, the sugars were about 19.8%, and this is consistent with (6).
The results in the same table show that when the time period of frying was fixed to 4 minutes with temperature change, the fat content in the chips was 18.03% at 100° and 21.32% at 130° and 28.12% at 150°, while 31.20% at 170°, and finally 34.04% at 180°. It is found that the lowest percentage of fat was at 100°, because this degree represents the boiling point of water and does not represent very deep frying, so different temperatures were used.
Potato chips at a temperature of 100° did not produce the desired strength of the potato chips, as they looked soft and untainted by the desired golden yellow color of the potato chips, indicating that they contained high amounts of moisture inside the pulp of the chips.

For protein, the protein content in the raw potato was found to be 2.7%. After deep frying of the potato chips, the frying time was set at 4 min with temperature changes at (100, 130, 150, 170 and 180°). The protein ratios were (1.16, 1.50, 1.19, 1.04 and 0.94%), respectively. The protein ratios were reduced in the models due to the formation of acrylamide during the Millard reaction.

Table (4-1) showed that the highest percentage of ash was at 180° for four minutes, at ratio of 3.11%, while the lowest percentage in the sample before the frying treatment was 1.0%. The variation in ash rates in the models is due to several reasons, including frying temperature and the rest of the components, the most important being the percentage of humidity and fat.

Table (4-1) shows that the proportion of sugars in the raw potato models (before frying) was 19.8%, which is the lowest percentage of sugars in the experimental models. This is due to the lack of use of temperature with a significant increase in humidity in the models. While the difference in the ratio of sugars to different degrees of temperature was observed, the temperature recorded 150° for 4 minutes as it was 1.79%, and the lowest temperature at 100° compared to 24.68% that the increase in the proportion of sugars by increasing the temperature due to excessive frying leads to a high percentage of sugars with a decrease in humidity of the models accompanied by a rise in fat ratio of the models. It was found that there was a positive relationship between the proportion of sugars and the amount of water evaporated as well as the case of sugars with fat.

Acrylamide
The ratio of acrylamide in the raw potato model (pre-frying) taken from the local markets by GC / MS was estimated to contain no concentration of acrylamide, as the sample was not subjected to temperature. This is consistent with (6)
Table (2) shows the proportions of acrylamide in fresh and fried potatoes.

| Treatments at different temperatures | Period of frying | Acrylamide ratio ppb |
|-------------------------------------|------------------|-----------------------|
| Fresh                               | 0                | 0                     |
| 100                                 | 4                | 136                   |
| 130                                 | 4                | 522                   |
| 150                                 | 4                | 989                   |
| 170                                 | 4                | 1523                  |
| 180                                 | 4                | 2416                  |

After the frying of the samples at different temperature degrees with the fixing time, it was found that raising the temperature of frying to 100° led to the formation of acrylamide, and this result is consistent with (8). Which indicated that the material of acrylamide formed at a temperature higher than 100. proved that the temperature of 100 ° C is the beginning of the formation of acrylamide in potato chips.

at the fixing of the frying period and temperature change, the lowest concentration of acrylamide was found at 100°C with a concentration of 136 μg / kg. This result is consistent with (9). As shown in Table (4-2) The concentration of acrylamide was 522 μg / kg. This result was consistent with (4), when he pointed to the formation of acrylamide in starchy foods during cooking at high temperatures such as frying and roasting. It was also observed in the table when the temperature was raised to 150°.; the concentration of acrylamide increased 989 μg / kg when the time was proved to boil and at the same thermal level for 4 minutes a reduction in the final humidity content was observed in the fried potato chips. This result is consistent with (10).

When increasing the temperature from 150° to 170° for the same period of frying, there was a significant increase in the concentration of acrylamide. (11) noted high levels of acrylamide in potato chips from local markets (700-1000 μg / kg). At 180 oC and 4 min, there was a significant increase in the concentration of acrylamide 2416 μg / kg

The results recorded in the table obtained by the Spectrophotometer showed that the higher the temperature, the higher the concentration of acrylamide in the fried potato chips. At the same time, the temperature of 180° is the thermal grade used for frying in the chip factories. The concentration of acrylamide was much higher than the levels recorded by (12). The most important factors affecting the concentration of acrylamide in the research models are the temperature used for frying and frying time.

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