



# Description of the Chemical Content and Properties of Convective Drying to Apple Fruit Snacks

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**Abstract.** Apple is a natural product rich in biological compounds, dietary fibers, macro elements and microelements. Convective drying is effective way to make such valuable raw materials to preserve and improve sensory properties for future consumers. Convective drying is an advanced means of preserving food products. The best possible results of the drying stage are achieved by performing numerous experiments. As a result, it is necessary to select the preferred characteristics of dehydration regimes on a scientific basis. Then it showed high-quality finished products with long shelf life property. Important to note that sensory and physical-chemical properties of the dried product were proved and noted at a heating temperature of 55 °C.

**Keywords:** Convective drying · fruit snacks · microelements · sensory analysis

## 1 Introduction

The development and production of new generation food products for healthy, functional and therapeutic nutrition is an innovative direction in food chemistry, which is of extremely important practical importance and social effectiveness. There is an increased attention to Kazakhstani products of natural origin: berries and fruits, as the main raw materials for the production of products for healthy and functional nutrition. This is due to their accessibility and consumer preferences of all population groups [1]. In the system of rational and balanced nutrition, a person needs two to three snacks during the day between main meals. Each meal should have an individual combination of proteins, fats, carbohydrates, fiber and with the specified parameters of caloric content and antioxidant activity. Fruit snacks are promising food products for these purposes. Fruit and berry snacks are a new direction in healthy eating. Fruit and berry snacks are thinly sliced, dried slices of fruits and berries without adding other ingredients.

It is a truth that crunchy and healthy natural product that does not require additional preparation and is ready to eat. Due to the careful vacuum drying technology, snacks retain almost all the necessary nutrients - vitamins and nutrients that are in the fresh product.

In the food industry, such products as sulfur dioxide, caustic soda, alkali and fats are used in the processing of fruit snacks [2]. During storage, fresh fruits deteriorate quickly due to enzymatic, biochemical and microbiological changes. Artificial or natural drying inhibits the growth of microorganisms. Fruits are characterized by a high water content and a low amount of dry matter. About 5% of moisture is associated with cellular structures, and most of it is in free form and can be removed using drying plants.

Fruits and berries are dried to increase storage stability, deteriorate packaging requirements and decrease weight shelf life of finished product [2]. New measurements in drying methods have been introduced to reduce energy consumption and operating costs. Specific values of mass transfer characteristics are required for effective design of both a new convective drying modes and equipment or modernization of existing systems [5].

The existing convective drying plants are made in the form of specialized structures using the laws of thermodynamics for drying raw materials, while creating an environment with the properties of a heat carrier in order to remove heat and dry fruits [3]. Moreover, it is vitally important to note that high temperatures and direct sunlight negatively affect the preservation of biologically active compounds such as vitamins and polyphenols. Increased nutritional value is provided against the background of analog canning. Compared with traditional technologies, freeze drying has a number of important advantages: after sublimation, products lose moisture and retain useful components; sublimation retains the shape, smell, taste and color of berries and fruits. Freeze-dried berries and fruits - melon, watermelon, apricot, plum, raspberry, strawberry, cherry, cherry and others, an ideal product for those who do not want to spoil dishes with artificially grown analogues, cares about the health of the consumer [4, 5].

The choice of fractions is thin slices with different sizes with gradation by fractions, gris or granules, powder, pieces of regular shape. After freezing, harmful microorganisms and fungi will not appear in the sublimates. 100% preservation of the structure, shape, color and beneficial properties of canned fruit. Freeze-dried fruits and berries in any period of the year after the restoration of their shape delight with their aromas and the quality of their natural texture.

## 2 Materials and Methods

Experimental studies were carried out in research laboratory of acting plant processing industry InnovTechProduct LLP, Kazakhstan. The experiments were conducted in the spring and summer months 2023 year.

There were used different methods of current research: Sensory analysis, quantitatively and qualitative methods of identification chemical contents of macro and microelements. Common accepted, standard methods of raw materials research were used to implement the tasks. Local apples growing in the South of Kazakhstan were used as raw materials.

The range of analyzed convective drying modes was selected in such a way as to ensure the preservation of useful elements in fruits [3]. The experiments were carried out on a laboratory convective drying unit at heating temperatures from 40 to 80 °C in increments of 5 degrees. The fruits were dried on pallets in one layer. The drying control parameters were the drying heating temperature (°C), the mass fraction of fruit moisture (%) [4].

### 3 Results

As a result of practical research, the duration of convective drying of objects at a temperature from 40 to 80 °C in increments of 5° was established.

To determine the sensory analysis, a technique was used that provides an assessment based on such indicators as color, taste, smell and consistency, each of which was evaluated on a 5-point scale [9,10]. Thus, the total maximum score was 20 points. Table 6 shows the results of the sensory evaluation of dry fruits (Table 1).

**Table 1.** The results of the sensory analysis of dry fruits when selecting the temperature of convective drying

Indicators	Temperature of convective drying, °C								
	40	45	50	55	60	65	70	75	80
Taste	4	4	5	5	4	3	2	2	1
Color	4	4	5	5	3	3	1	1	1
Smell	4	4	5	5	3	2	2	2	0
Texture	4	4	5	5	3	2	4	2	2
<i>Total</i>	16	16	20	20	15	10	9	7	4

The best results of sensory properties for apple fruit snacks were observed when the heating temperature was in the range of 55–65 °C. It was evaluated from 16 to 20 points. But further increasing of temperature of convective drying to 80 °C showed a deterioration of the sensory analysis to 2 points. The maximum scores of sensory characteristics according to the table were obtained at a heating temperature of drying apples of 50–55 °C.

Next table showed qualitative and quantitatively chemical composition of apple fruit snacks: Moisture (Methods for determining moisture according to all-Union State Standard 28561–90), free acids (Methods for determining titratable acidity according to all-Union State Standard 25555.0–82), total and invert sugar, pectin substances, tannins and cellulose (Table 2).

**Table 2.** Chemical composition of apple fruit snacks

Indicators	Apple fruit snacks, %
Moisture, %	89
Free acids, %	2,19
Total sugar, %	12,35
Invert sugar, %	2,38
Pectin substances, %	0,92
Tannins, %	0,23
Cellulose, %	0,58
Nitrogenous substances, %	0,20
Ash, %	0,44

**Table 3.** Analysis of the mineral composition of ash residues of apples, growing in the Turkestan region [7, 9, 10]

	Name of indicators, mg/kg	Fruit apple snacks (in ash residues)
		Mass fraction of ash, in %- 0,6
1	Fe, mg/kg	508,208
2	Li, mg/kg	390,351
3	Mg, mg/kg	6996,66
4	P, mg/kg	20633,1
5	K, mg/kg	32898,7
6	Ca, mg/kg	8849,24
7	Ti, mg/kg	58,2545
8	Mn, mg/kg	64,3344
9	Cu mg/kg	52,9941
10	Zn, mg/kg	253,027
11	As, mg/kg	35,8967
12	Se, mg/kg	2,87834
13	Rb, mg/kg	212,386
14	Sr, mg/kg	97,8233
15	Zr, mg/kg	9,83151
16	Mo, mg/kg	5,84383
17	Ba, mg/kg	822,369
18	Pb, mg/kg	9,15406

From Table 3, Among analyzed characteristics apple fruit snacks contains sufficient amount of biological compounds. After that samples after convective drying and mineral

composition of ash residues were subjected to the determination of the quantitative content of chemical elements by inductively coupled plasma mass spectrometry on the basis of the regional engineering laboratory “Structural and Biochemical Materials”. This method allows the determination of a number of metals and several non-metals in concentrations up to  $10^{-10}\%$ , i.e. one particle out of  $10^{12}$ . The method is based on the use of inductively coupled plasma as an ion source and a mass spectrometer for their separation and detection.

## 4 Discussion

The optimal technological characteristics of sensory properties in apricots (from 16 to 20 points) were noted in the following situation. The heating temperature was in the range of 40–85 °C. When the temperature rises to 80 °C the scores of sensory properties are reduced to 2 points.

Current studies have been conducted on the effect of heating temperature on the efficiency of the convective drying process of apples. For reasons of the most rational ratio of dehydration time and the degree of preservation of valuable components of fruit raw materials, the following heating temperature values for convective drying can be recommended: for apples –50–55 °C. The obtained experimental results can be used in engineering practice in the technology of fruit and vegetable processing.

As it is shown on the Tables, apple fruit snacks contain a high content of useful microelements: Fe, Ca, K, P, Mg, Zn, Cr, Ag and fibers and valuable biological compounds.

Convective drying is an advanced means of preserving food products [1]. The best possible results of the drying stage are achieved by performing numerous experiments. As a result, it is necessary to select the preferred characteristics of dehydration regimes on a scientific basis. Definitely it will show high-quality finished products. Important to note that sensory and physical-chemical properties of the dried product will be proved.

## 5 Conclusion

The perspective directions of convective drying of local apples of Turkestan region for fruit snacks are described. To conclude important to summaries results of chemical content of apple fruit snacks after convective drying. The optimal technological characteristics of sensory properties in apples fruit snacks (from 16 to 20 points) were noted in the current research. Proposed method of convective drying was used to confirm the effect of heating temperature on the sensory properties of finished products on the modern market. Taking into account the optimal chemical content of fibers, iron, and microelements should be recommended for the production of fruit processing in Turkestan region with idea to preserve biological compounds and prolong shelf life.

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