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EFFECTS OF SOME TECHNOLOGICAL TREATMENTS OF QUALITY AND SAFETY OF APPLE CONCENTRATE

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Abstract

In this research the production of apple concentrate obtained by varieties Golden Delicious and Ajdared was followed, through the technological stages: milling, pressing, pasteurization, depectinization, filtration, concentration.

Preserving the content of vitamin C is of particular importance for the quality of products. Therefore, in this research changes in content of vitamin C through all stages of technological processes were followed. In terms of safety, analyses were carried out for assessment of the content of heavy metals (lead, mercury, arsenic, copper, cadmium, chromium), pesticides (organ-chlorine and organ-phosphorus insecticides). Also, microbiological examinations are of particular importance for the safety. Therefore, at certain stages of the technological process the number of mesophilic aerobic bacteria, *Salmonella* species, yeasts and molds were determined.

From the gained results it can be concluded that the percentage of vitamin C decreased after pasteurization and after concentration. The content of heavy metals and pesticides in all stages were acceptable according to regulations and the apple concentrates was microbiologically safe.

Key words: *Apple concentrate, grinding, pressing, pasteurization, depectinization, filtration, concentration*.

1. Introduction

The world's food production issue is becoming increasingly important. The need for larger quantities of food is based on the constant increase in population. On the other side, owing to the fact that the industrial pollution of the natural environment and the use of chemicals in agriculture are more significant, the production of healthy and qualitative food is every day harder and harder, the soil and climate conditions in the Republic of Macedonia are very suitable for producing quality fruits for fresh consumption and processing. The fruit processing in the final and semi-final products can be obtained with superior heat product's correct value (Niketic-Aleksic [1]).

The fruits, especially apples as fruit type are extremely suitable for growing in warmer areas of temperature climate. It is fruit in appearance and quality represent the ideal raw material for manufacturing various types of processing as well as producing a semi product (concentrated apple juice).To produce semi products or concentrated fruit juice, it is necessary to use types of apples with higher content of dry matter, and higher content of Vitamin C and flavor. Since the period of harvesting the apple fruits is relatively short and requires additional storage costs, our main goal was just to revamp and get semi product which can be easily stored and kept, and the economic effect is much larger. Concentrated apple juice is a semi product obtained by concentrating the juice after the application of certain physical processes. The concentration of the juice can be performed by evaporating under vacuum (Veličkovič [2]).

Also, the goal of this examination is to increase the producing of qualitative and safe semi products in Macedonia, which still has a large flow of foreign currencies, whereas the production of apples often fails. From this point we get to the goal of this afford which will address the core issues and problems associated with the excess of apples, and through that

a qualitative and safe apple concentrate. In all stages of processing, until the receipt of the semi product (the apple concentrate), the next is the quality during the production, through the content of the Vitamin C, meanwhile the microbiological safety is monitored, as well as the content of pesticides and heavy metals (Karaka{ova [3]).

2. Materials and Methods

We used two types of apples as material samples: ajdared and zlaten delises. Apple fruits were taken from Prespa region. The choice of the types was made according to some previous examinations, based on a greater content of dry matters, with particular emphasis on Vitamin C and the delicious taste of the fruits.

The technology of getting an apple concentrate was applied in the fruit processing and fruit juice production factory Gudalat-Gostivar, a factory whose products are released based on the principles according to ISO9001:2000, BRC, HACCP standards. Samples were taken from these technological stages: grinding (X1), extrusion (X2), pasteurization (X3), depectinization (X4), filtration (X5) and concentration (X6) (Figure 1).

The following parameters were also analyzed in the same samples which are the base of the quality and the product safety (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketic-Aleksic [6]):

- The content of the Vitamin C is determined by iodometric method, and we also conducted a comparison to HPLC;
- Pesticides - by gas chromatography GC;
- Heavy metals (Lead, Mercury, Arsenic, Copper, Cadmium, Chrome) - by AAS;
- The number of aerobic mesophillic bacteria, Salmonella species of bacteria, yeasts, moulds.

Samples were tested in the PHI Institute of Public Health of the Republic of Macedonia-Skopje, according to the requirements of the standard MKS EN ISO/IEC 17025:2005 for chemical, radiological and microbiological testing of food. Vitamin C according to the law on quality of fruit, vegetables, mushrooms and pectin preparations (Sl. list SFRJ 1/79 and 20/89).

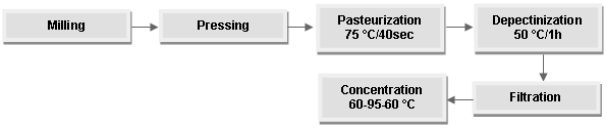
Heavy metals are tested only in the samples X1 and X6, and it the content of the following substances can be noticed:

Lead EN 14084 (14083), Mercury EN 14084 (14083), Arsenic EN (14084), Copper EN 14084 (14083), Cadmium EN 14084 (14083), Chromium EN 14084 (14083), which are reference methods according to Law on the general requirements for food safety (Official Gazette of R.M. 118/2005).

Pesticides (organ phosphorus insecticide), (organ chlorine insecticides), according to the law on the general requirements for food safety (Official Gazette of R.M. 118/2005).

At the microbiological accuracy the number of mesophillic aerobic bacteria has been established according to ISO 4833, for *Salmonella* spp. was used ISO 6579 method and for yeasts & moulds was used ISO 7954 method, all of them according to the Law on special requirements for food safety in terms of microbiological criteria (Official Gazette of R.M. 78/2008).

Technological process for the production of the apple concentrate is conducted in the following Scheme 1:



Scheme 1. Technological process for the production of apple concentrate

Figure 1. Samples per phase of production

The process of production of apple concentrate was conducted in the following order:

-Milling, was performed in a short period of time in mills made of stainless steel and mills in a closed isolated system without any access to oxygen, because our main task is to preserve the content of the Vitamin C as a major antioxidant asset and the main factor in preserving the colour. (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketic-Aleksic [6]);

-Pressing, is carried out with a press type, by this procedure the separation of the juice and the pulp is made and the technological process should be performed in a short period of time in order to reduce the oxidation process (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketic-Aleksic [6]);

-Pasteurization, this process was performed at a temperature 75 °C/40 sec, with this procedure we inactivate the enzymes, reduce and partly destroy an amount of microorganisms. Here a HTST is applied in order to preserve the thermo labile components of the concentrate (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketic-Aleksic [6]);

-Depectinization, with this process we remove the pectin substances using enzyme preparations. The presence of pectin causes blurring. Specifically in our experiment this technological operation was performed at a temperature 50 °C for 1-1.5 hour (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketi}-Aleksi} [6]);

-Filtering, this operation was carried out in special filters that are also applied on a regular production process in the factory (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketi}-Aleksi} [6]);

-Concentrating, this technological process is performed after the filtrated juice is evaporated under vacuum evaporators, and the concentration is carried out in three phases: The first phase achieves a concentration of 20 25 °Brix at 60 °C, the second phase achieves a concentration of 40 to 60 °Brix to 95 °C, and the third phase achieves an optimal concentration of 65-71 °Brix, whereas the exit temperature is 50-60 °C and later the concentrate is exposed to cooling so the biochemical processes will stopped (Lovric and Pilizhota [4], Kongoli and Boci [5] and Niketi}-Aleksi} [6]).

3. Results and Discussion

The results of tests made on apple concentrate are given in Tables 1-4 and Figures 2-4.

Table 1. Comparative values of vitamin C content of various samples obtained by the quoted methods

Sample	Vitamin C (mg/100g)	
	By HPLC method	*Iodometric method*
X1 - Milling mass	3	4.4
X2 - Press juice	-	3.52
X3 - Pasteurized juice	-	1.76
X4 - Depectinized juice	-	1.76
X5 - Filtered juice	2.1	1.76
X6 - Concentrate	2.7	4.4

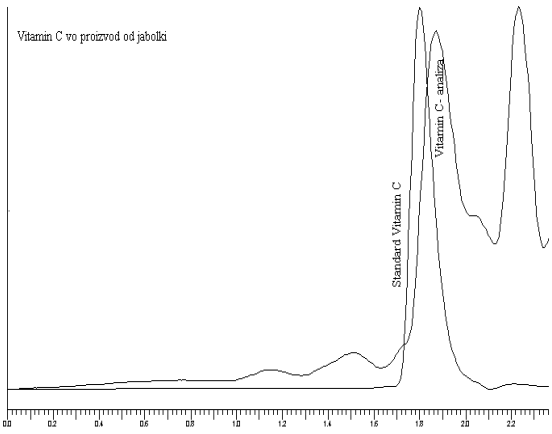


Figure 2. Content of vitamin C by-HPLC

From Table 1 can be concluded that the content of vitamin C is highest in the fresh broth milling mass 3 mg/100 g on HPLC and 4.4 mg/100 g by iodometric method (Farmakopeja [7]), which is plausible. In subsequent samples obtained from the next stages of production, we have a permanent reduction of the vitamin C content. Drastic change of the vitamin C was determined after pasteurization technology operation (X3) from 3 to 2.1 mg/100 g on HPLC and from 3.52 to 1.76 mg/100 g by iodometric method. We also found large reductions in the sample obtained after concentrating the technological operation that can be seen in the same table. The different values that were obtained for the content of vitamin C on two different methods of determining the individual samples are due to the exact HPLC method.

Table 2. Pesticide Residues in the sample X1 and X6

Organ phosphorus insecticides	SAMPLE Pesticides (mg/kg/L)		Organochlorine insecticides	SAMPLE Pesticides (mg/kg/L)	
	X_1	X_6		X_1	X_6
Phorate	<0.02	<0.02	Lindan	0.01	0.01
Pirimiphos-methyl	<0.02	<0.02	HCH(alfa+beta)	0.01	0.01
Fenitrothion	<0.02	<0.02	Aldrin	0.01	0.01
Chlorpyriphos-methyl	<0.02	<0.02	Dieldrin	0.01	0.01
Malathion	<0.02	<0.02	HCB	0.01	0.01
Parathion-methyl	<0.02	<0.02	2.4DDE	0.01	0.01
Parathion	<0.02	<0.02	4.4DDE	0.01	0.01
Phosalone	<0.02	<0.02	2.4DDD	0.01	0.01
Fenamiphos	<0.02	<0.02	2.4DDT	0.01	0.01
			Beta Endosulfan	0.01	0.01
			Delta HCH	0.01	0.01

Table 2 provides data on pesticide residues in the initial and final samples, X1 and X6. From the given results we can come to conclusion that pesticide residues in the sample X1 and X6 are located in the acceptable limits according to the general requirements for food safety (Official Gazette of R.M.118/2005). Pesticide residues in sample obtained from fresh apple X1 and sample apple concentrate X6 are in traces, and it may be concluded that is safe product.

Table 3. Residues heavy metals in the sample X1 and X6

Heavy metals	Sample (mg/kg/L)	
	X_1	X_6
Lead	0.075	No trace
Mercury	0.018	No trace
Arsenic	0.066	No trace
Copper	1.14	No trace
Cadmium	0.05	No trace
Chrome	0.068	No trace

Table 3 provides data for residues of heavy metals in the samples X1 and the final X6. From the results we can conclude that the heavy metal residues in the samples X1 and X6 are located in the acceptable limits according to the general requirements for food safety (Official Gazette of R.M. 118/2005), and it may be concluded that it is a safe product.

Table 4. Microbiological accuracy of samples X1 and X6

Types of microorganisms	Sample			
	X_1		X_6	
	Result	*Unit*	*Result*	*Unit*
Aerobic mesophilic bacteria	1000	cfu/g	0	cfu /g
Salmonella spp.	0	absence in 25g	0	absence in 25g
Yeast & Mould	1000	cfu/g	0	cfu/g

From Table 4 we can conclude that the content of the sample X_1 aerobic mesophilic bacteria is 1000 cfu/g, *Salmonella* spp. were absent in 25g, yeast & moulds were found 1000 cfu/g, while in the X6 sample, the abovementioned microorganisms were not found. With the thermal process a minimum number of resent microorganisms have been destroyed. So we conclude that in terms of microbiological accuracy, this is a safe product (Ashurst [8]). According to the law on special requirements for food safety in terms of microbiological criteria (Official Gazette of R.M. 78/2008) qualifies as safe.

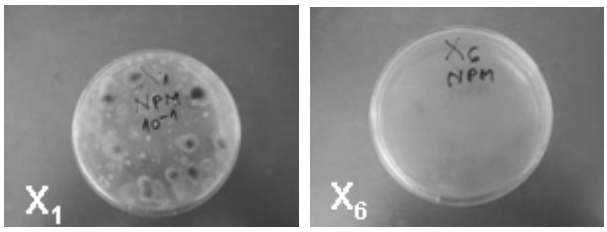


Figure 3. Aerobic mesophilic bacteria

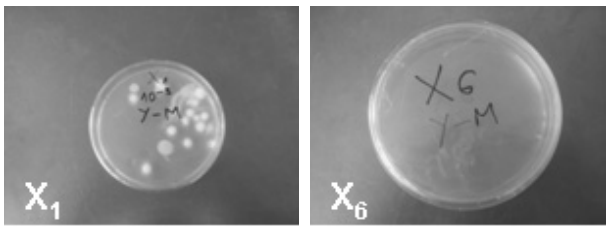


Figure 4. Yeasts & Moulds

4. Conclusions

Based on the analysis and the obtained results we bring the following conclusion:

1. The content of the vitamin C in the apple concentrate with a dry matter content of 65-71 °Brix is satisfactory limits (4.4 mg/100 g), and represents a guarantee for preserving the quality of the finished product. The method by HPLC in our case showed as a precise.
2. The pesticides residues in our sample are within acceptable limits prescribed in the Rules for general safety requirements for food (Official Gazette of R.M. 118/2005).
3. Residues of heavy metals are also included in the limits acceptable under the Rules of the general requirements for food safety (Official Gazette 118/2005).
4. It is confirmed that is microbiologically correct product by the Rules of specific requirements for food safety in terms of microbiological criteria (Official Gazette of R.M. 78/2008).

The applied technological procedure we added guarantee of obtaining high-quality and safe product, as confirmed by the results obtained. By implementing the processing and receiving apple concentrate from domestic production and transforming it into clear juice in general practice will increase: the income of agriculture producers, the production of apples, the employment and the foreign exchange inflow into our country.

5. References

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