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Influence of Different Drying Methods over the Biochemical Compositions of Japanese Quince

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Abstract- The experiment was conducted in Cooperation between RIMSA-Troyan and FRDI-Plovdiv. The biochemical composition was analyzed in fresh fruits from selected (perspective) genotypes of Japanese quince. Changes in chemical indicators in dried fruits and their analogues were also studied. In order to achieve the aim, the following variants for drying of fruits were included in the experiment: by means of an alternative energy source, a heat pump, and indoor temperature. Chaenomeles fruits are characterized with low content of sugars, and relatively high amount of organic acids. The ascorbic acid amount reached up to 102 mg% in genotype 6'. There was a high content both of tanning substances - 0,542 % (genotype 1'), and pectin - 1.07% (genotype 6'). A significant increase of organic acids, tanning substances and pectin was reported in dried fruits from different variants of drying.

The aim includes a comparative analysis among variants for fruit drying with regard to the degree of retaining the biochemical composition indicators.

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Abstract- The experiment was conducted in cooperation between RIMSA-Troyan and FRDI-Plovdiv. The biochemical composition was analyzed in fresh fruits from selected (perspective) genotypes of Japanese quince. Changes in chemical indicators in dried fruits and their analogues were also studied. In order to achieve the aim, the following variants for drying of fruits were included in the experiment: by means of an alternative energy source, a heat pump, and indoor temperature. Chaenomeles fruits are characterized with low content of sugars, and relatively high amount of organic acids. The ascorbic acid amount reached up to 102 mg% in genotype 6'. There was a high content both of tanning substances - 0,542 % (genotype 1'), and pectin - 1.07% (genotype 6'). A significant increase of organic acids, tanning substances and pectin was reported in dried fruits from different variants of drying.

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I. Introduction

Dried fruits from Chaenomeles sp. are used from thousands of years in Chinese medicine. The Ancient written information about this use of *Chaenomeles sp.* Lindl. as a drug was found in the book "Mingyi Bielu" by Tao Hongjing in the eastern literature for more than 1500 years ago (at about 500th D.C.) (Chace and Zhang, 1997; Yang Y., 2002). Japanese quince is a valuable remedy in China, and occupies a significant component of their prescriptions. The therapy is based on the ancient concept that acidic taste softens the liver (liver belongs to the element "tree") and thus relaxes the tendons, which are considered under the control of the hepatic system). (Yü and Kuan 1963; Anon. 1989; Chace and Zhang 1997; Yang Y., 2002).

Drying is a method that has been applied as a way to preserve fruits. The process includes different variants of application in order to obtain the finished product. It is opened, as it is being improved all the time in the different stages and elements of technology. An important element in the different drying technologies is to follow the changes in biochemical compositions of fruits (Morelló et al., 2003; Меженский, 2004; Мондешка, 2005; Graeme et al., 2007; Рупасова и др., 2008; Figueiredo, 2009; Zhu et al., 2012; Zhang et al. 2014).

Genus Chaenomeles is native in the the province Chongqing, China for hundreds of years, grown widely and is a traditional herb. Dried fruits in the form of dust are a dietary supplement used to prevent atherosclerosis and have antioxidant effects (Tang et al, 2000; Dharmananda; 2005; Malgorzata et al, 2007; Tang et al, 2010). In this connection, a method for the production of flours superfine powder with UF-250 airflow micronizer (Ka Chen et al., 2014).

It is very important to preserve the values of different biochemical indicators during the process. The influence of genotype and the respective drying technology for fruits is significant. These characteristics are important both for the qualities of a specific species, and for the suitability of the respective drying method. Different modes of the process lead to respective changes in the indicators of the biochemical composition of fruits. The temperature, humidity and duration of the process are essential. The fruit species is important to a great extent in order to determine the technology.

The aim is to follow the changes in biochemical composition of fruits under different drying technologies

II. Material and Methods

The experiment was conducted in cooperation between RIMSA-Troyan and FRDI-Plovdiv.

Selected genotypes of *Chaenomeles* genotypes the collection plantation of RIMSA were included. The following genetic types of *Chaenomeles* were included in the study: 1', 3' and 6'.

The drying process of fruits was conducted by means of:

I variant - heat pump
II variant - using alternative energy source
II variant - in a closed room with air circulation

The following indicators were studied: dry matter according to refractometer (Re%); sugars % (total, inverted and sucrose) according to the method of Schoorl and Regenbogen; Organic acids %; ascorbic acid according to method of Fialkov; tanning substances according to Levental method; pectin according to Melitz method. Analyses were conducted in the chemical laboratory of RIMSA.

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Data were mathematically processed by means of two-factor analysis of variance. For assessment of differences was used LSD indicator (Lidanski, 1988).

III. Results and Discussion

Chaenomeles fruits have higher values for some of the biochemical indicators, and for others they are lower in comparison with fruit of other tree species. There is a difference in the biochemical composition of the final product of different genotypes to methods of drying. Similar studies of various methods of drying the fruit and vegetables have been conducted by Sagar and Kumar (2010). They describe in detail the influence of drying the quality of products.

For selected genetic types, dry matter in fresh fruits has insignificant differences, which are within the intervals from 7% (genotype 6') to 8.5% (for the other two genotypes) (Table 1). Differences in dry weight matter were more significant. For genotype 6' it was 10.39%, and it was the highest in genotype 1' - 12.52%.

Content of sugars was low, which is characteristic for that species. Total sugars for the three genotypes were within the range of 4-5%. Disaccharides were presented in lower amount for genotype 3'- 2.7 %, they were higher for genotype 6'- 3.05 % and genotype 1'- 3.55 %. Sucrose content was in small amount for genotype 1' and 6'- 0.76 %, and about two times more for genotype 3'- 1.9 % Organic acids were in optimal values for that fruit tree species. They were almost the same for the three genotypes within the range 2.14% - 2.41 % Ascorbic acid was an indicator with high values for Chaenomeles fruits. It reached up to 102.08 mg/% for genotype 6'.

Tanning substances, which largely determine the tart taste of fruits, varied within the range from 0.354 % (genotype 3') to 0.542 % (genotype 1'). According to Mondeshka (2005) Japanese quince is a valuable source of phenolic compounds (500 mg / 100 g), and anthocyanins and leykoantotsianins (greater than 700 mg / 100 g), K (85,5), Ca (22,7), Mg (12 , 0), P (27,4). It also contains Fe, Mn, Al, small amounts of Cu, Zn, B, Na and Sr, but the most valuable is the high content of vitamin C in fruit - 124-182 mg per 100 g of fruit.

Pectin is the other indicator where was reported a significant variation of values among genotypes. It was the lowest for genotype 3'-0.37 % and higher for genetic types 1' and 6', respectively 0.98% and 1.07 %. Рупасова и др.(2008) investigated the biochemical composition of different genotypes and varieties of Japanese quince.

Dry weight matter in dried fruit for the three variants was within values from 80% to approximately 91%. That indicator was the highest for fruits dried in heat pump. For the other two drying methods, values were almost identical with the exception of genotype 6' of the third variant, where it was the lowest - 80.92%. The results show that the drying process was completed in a normal way (Table 1).

There was a significant variation of sugar content as a whole. The values of total sugars were much higher in heat pump drying, which varied in the intervals 12.6% - 15.35%. They were lower for the other two variants. There is a significant difference between genotype 1' and the other two for all the three variants. The values of genotype 1' were the lowest for the third one - 3.55%. Drying method has an influence over the indicator. Differences among the first and the other two drying variants were mathematically proven ($P<0.05$) (Table 2).

The results were analogous in relation to the other indicator - inverted sugar. It reached values from 12.1% for genotype 3' in the first variant. They were a few times less for genotype 1' than the alternative energy source and in a closed room with air circulation, respectively - 4.7% and 2.7%. Differences were very well proved between the first and third variant ($P<0.001$).

Table 1: Biochemical composition of chaenomeles fruits in different drying variants

Drying variants	Genotype	DM in %	Dry weight	Total sugars %	Inverted sugar %	Sucrose %	Acids %	Ascorbic acid mg/%	Tannins %	Pectin %
Fresh	1'	8.5	12.52	4.35	3.55	0.76	2.21	96.80	0.542	0.98
	3'	8.5	11.71	4.70	2.70	1.90	2.41	88.00	0.354	0.37
	6'	7.0	10.39	3.85	3.05	0.76	2.14	102.08	0.400	1.07
Heat pump	1'		90.84	12.45	10.75	1.62	9.67	49.28	0.896	0.13
	3'		90.74	15.35	12.10	3.09	10.59	24.16	0.990	0.20
	6'		89.69	12.60	11.10	1.43	10.53	49.28	1.179	4.17
Sun dryer	1'		87.82	5.70	4.70	0.95	10.25	31.68	0.802	3.61
	3'		86.71	8.55	8.55	0.0	10.45	22.88	0.377	2.84
	6'		90.04	8.55	8.55	0.0	10.05	35.20	0.684	3.11
In a closed room	1'		86.64	3.55	2.70	0.81	9.85	19.36	0.684	2.29
	3'		86.62	6.85	6.35	0.48	10.39	19.36	0.707	1.30
	6'		80.92	8.55	8.55	0.0	10.18	22.88	0.802	2.43

Table 2: Significance of factors influencing the values of qualitative indicators of Chaenomeles fruits

Indicators	DM in %	Dry weight	Total sugars %	Inverted sugar %	Sucrose %	Acids %	Ascorbic acid mg/%	Tannins %	Pectin %
Genotypes	NS	NS	NS	NS	NS	NS	NS	NS	NS
Different methods of drying	NS	NS	P<0.05	P<0.01	P<0.05	NS	P<0.05	P<0.06	NS
LSD	-	-	3,07	5,4	1,46	-	15,61	-	-

Sucrose amount was the highest for genotype 3' in the first variant - 3.09%. Calculated in relation to absolute dry matter, the decrease in comparison with fresh fruits was 6.6 times. For the other two variants sucrose had lower values, and for some genetic types it was completely missing. There were proven differences for that indicator in drying technologies between the first and the other two variants (P<0.05).

The increase of organic acids was approximately five times in dried fruits in comparison with fresh ones. There were no significant values for forms of the different genetic types. The values of that indicator were within the range from 9.67% (genotype 1') to 10.53 % (genotype 6').

In regard to biologically-active substance of ascorbic acid, the decrease was dramatically in dry fruits in comparison with fresh. The decrease was approximately five times in dried products. Probably that was due to the oxidation process in fruits during storage period. The highest values were recorded for genotype 1'and 6' in the first variant - 49.28 mg/%. The lowest values were observed for genotypes 1' and 3' in the third variant. Probably, the amount of ascorbic acid is influenced by drying technologies of fruits.

There was a significant increase of tanning substances in dried fruits for some genotypes. For genotype 6' in the first variant they reached values up to 1.179 %, which is 2.9 times more than content in fresh fruits. Recalculated to absolute dry matter the decrease was 4.4 times in the dried product. Variability of that indicator was within wide limits for genotypes in different variants. The lowest values were recorded for genotype 3'- 0.377 % in the alternative energy source variant. The decrease towards dry units was 9.7 times. There is a tendency of influence of the drying method over values of tanning substances.

There was a significant variability in pectin values in different variants. It is worth noting its amount for genotypes 1' and 3' respectively: 0.13 % and 0.2 % in heat pump drying variant. For first genotype the decrease in fresh fruits was 7.5 times and for second one it was 1.9 times. The highest values of that indicator were recorded for genotype 6' of all variants, as in the first one the pectin amount reached up to 4.17 %. Its decrease towards dry units was 3.3 times. As a complex assessment for the three genotypes, in relation to higher pectin values, the drying variant of the alternative energy source could be determined.

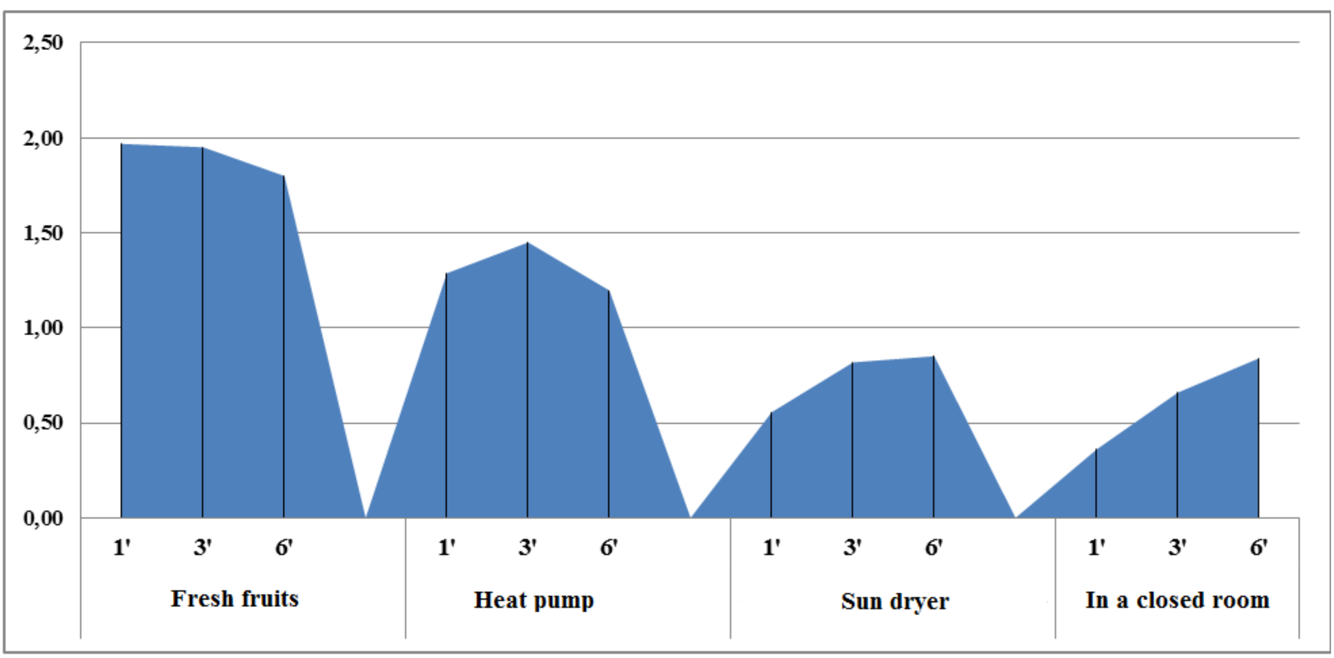

Figure 1: Acidometric coefficient of chaenomeles fruits in different drying variants

Sugar-acid coefficient in fresh fruits reached values up to 1.97 % (genotype 1‘). For the other two genotypes it was in close ranges. In the heat pump drying variant, values were closest to fresh fruits, which were in the interval 1.20% (gen. 6‘) – 1.45 % (gen. 3‘). Significantly lower were for the other two methods (Figure 1).

IV. Conclusion

A complex assessment was made to different drying variants of fruit drying of some perspective *Chaenomeles* genotypes.

The influence of different drying methods of *Chaenomeles* genotypes over their biochemical composition was studied.

It was found that sugars and ascorbic acid of the three genotypes were better preserved in heat pump drying variant.

Some regularities were reported of higher values for some indicators of genotypes from different drying variants.

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