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STUDY ON THE POSSIBILITY OF PROCESSING WHITE STRAWBERRY (*FRAGARIA* × *ANANASSA* 'SNOW WHITE') FRUITS INTO PRODUCTS FOR MASS CONSUMERS AND AS COMPONENT COMPOSITIONS IN THE BAKERY AND CONFECTIONERY INDUSTRY

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Abstract

This study examines the possibility of developing products from white strawberries, considering their short harvesting and storage period. Two product assortments - white strawberry jam and white strawberry with quince (Chaenomeles) jam - were developed and analysed at the Institute of Food Preservation and Quality in Plovdiv. The fruits were cultivated and provided by the experimental field in Chelopechene, part of the Institute of Soil Science, Agrotechnologies, and Plant Protection "Nikola Poushkarov" in Sofia. The jam production technology was modified based on the component composition of the product containing white strawberries and quince. The obtained products were analysed at the Laboratory of the Institute of Food Preservation and Quality in Plovdiv and the Department of Microbiology at the University of Food Technologies in Plovdiv. The analysis included physicochemical, biochemical, and microbiological indicators in compliance with current food safety and quality legislation. The final products are intended for mass consumers and as potential components in the confectionery and bakery industries.

Key words*: white strawberry Fragaria × ananassa* 'Snow White'*, Chaenomeles, technology, products, biochemical, microbiological indicators.*

INTRODUCTION

The white strawberry (*Fragaria* × *ananassa*) is biologically identical to the common strawberry and belongs to the same species. The 'Snow White' variety was developed in 2010 by crossbreeding *Fragaria* × *ananassa* 'Weisse Ananas' and *Fragaria chiloensis* f. *chiloensis*.

The fruits of this remontant white strawberry variety are smaller, rounded, and conical, measuring between 15 and 33 mm. Their color ranges from white to creamy, with pale pink shades and red seeds. At the beginning of ripening, the fruits are green, turning white when fully ripe, while the seeds become deep red. The flesh is soft, juicier than common strawberries, colored from white to pale pink, with a sweet-sour taste and a strong aroma. The absence of bioflavonoids (biologically active plant polyphenolic compounds known as flavonoids) results in the lack of the characteristic red hue in ripe fruits. The deficiency of one of the main ripening proteins in strawberries, *Fra a1* (commonly known as *Fragaria* allergen A1), allows consumers with strawberry allergies to consume white strawberries without experiencing side effects or allergic reactions.

The quality and nutritional value of the fruit depend on the applied agrotechnical cultivation technologies. Strawberries of the species *Fragaria* × *ananassa* are an important dietary source of vitamins, minerals, fiber, and other bioactive compounds that have beneficial effects on human health. Specific compounds, such as phenols present in these fruits, exhibit various biological activities, including antioxidant, neuroprotective, anticancer, anti-inflammatory, and antimicrobial properties (Moyer, 2002; Cirico et al., 2006; Galli et al., 2006; Markovic et al., 2000; Ramirez-Tortosa et al., 2001; Karakaya et al., 2004).

White strawberries contain carbohydrates (9.16%), proteins (0.66%), fats (0.26%), citric acid (1.08%), ascorbic acid (1354 mg/kg), total carotenoids (6.6 μg/100 g), pectins (0.96%),

among other compounds. Their energy value is 173.64 kJ/42 kcal.

Chaenomeles sp., a perennial shrub from the *Rosaceae* family, is widely recognized as an ornamental plant. However, its fruits possess high biological value due to their biochemical composition: phenolic compounds (over 500 mg/100 g), leucoanthocyanins and anthocyanins (over 700 mg/100 g), vitamin C (124-182 mg/100 g), potassium (85.5 mg%), calcium (22.7 mg%), magnesium (12.0 mg%), and phosphorus (27.4 mg%). Researchers such as Chakhovsky et al. (1986), Petrova (1987), Mezhensky (1989), Hellín et al. (2003), Krasnova et al. (2007), and Mihova et al. (2012) have focused their studies on the valuable properties of this fruit.

The fruits of *Chaenomeles* sp. have a relatively high yield and are a valuable source of nutrients essential for human health, including organic acids (up to 5.5%), pectin (1.4 g/ 100 g), dietary fiber, and aromatic compounds (Kumpan & Sukhotskaya, 2010). They are also considered a non-traditional ingredient in food product development in Bulgaria (Mondeska, 2005; Hellín et al., 2003).

The aim of this study is to explore the possibility of processing white strawberry fruits into an innovative product with excellent taste qualities, intended for mass consumers and as a component in the bakery and confectionery industries, considering the fruit's short storage period.

MATERIALS AND METHODS

Raw Materials

White Strawberry – The fruits were grown in an experimental field of the Institute of Soil Science, Agrotechnologies, and Plant Protection "Nikola Poushkarov" in Chelopechene, Sofia. They were cultivated in an unheated greenhouse under 75% drip irrigation and 100% fertigation ($N_{8.09}P_{12.76}K_{15.62}$).

Chaenomeles sp. Fruits – The fruits were harvested from the demonstration plantation of the Institute of Mountain Livestock Breeding and Agriculture (IMLBA) in Troyan.

Experimental Design

Production Process of White Strawberry Jam - the jam was prepared using the following technological stages: reception of the fruits; sorting and washing; removal of stems from the white strawberries; crushing; addition of sugar; boiling to 60-62% dry matter (refractometric method); addition of pectin; •pH adjustment with citric acid; boiling to 65% dry matter; hot filling at t = 80-85°C; sealing; pasteurization at t = 96°C for 10-15 minutes; cooling and storage at t = 20-25°C.

Production Process of White Strawberry and *Chaenomeles* Jam - the jam was produced using the following technological steps: reception of the fruits; sorting and washing; removal of seeds from *Chaenomeles* fruits and stems from white strawberries; crushing; addition of sugar; boiling to 65% dry matter; hot filling at t = 80-85°C; sealing; pasteurization at t = 96°C for 10-15 minutes; cooling and storage at t = 20-25°C

Methods

Dry Matter (Refractometric), % - BDS EN 12143-2000;

Dry Matter (Gravimetric), % - BDS 7133:1981;

Active Acidity (pH) - BDS 11688-1993;

Color Measurement - Determined instrumentally using a colorimeter (PCE-CSM 5 portable colorimeter - measurement geometry 8°/d, Ø 8 mm, light source D65). The parameters were recorded using the CIE Lab system, measuring three color coordinates:

- L - Brightness (L=0 - black, L=100 - white);
- a - Positive values indicate the red component, negative values indicate the green component;
- b - Positive values indicate the yellow component, negative values indicate the blue component (ASTM D2244-16);

Carbohydrates, % - BDS 7169-1989;

Fats, % - BDS 6997-1984;

Proteins, % - BDS 14431-1978;

Total Titratable Acidity, % - BDS EN ISO 12147-2000;

Ascorbic Acid, mg% - BDS 11812-1991;

Energy Value, kJ - According to EC Regulation 1669/2011, Chapter IV, Section III, Article 31, Annex IV, and Bulgarian Ordinance No. 23/2001 of the Ministry of Health;

Organoleptic Evaluation - ISO 13299-2016;

Mesophilic Aerobic and Facultative Anaerobic Microorganisms, cfu/g - BDS 6916-1987;

Mesophilic Anaerobic Microorganisms, absence in 1 g - BDS 6916-1987;

Molds and Yeasts, cfu/g - BDS 6916-1987.

The presented results are arithmetic mean values from at least three parallel determinations, with variation coefficients of less than 5%. The statistical processing of the data was performed using variance analysis in Microsoft Excel.

RESULTS AND DISCUSSIONS

The data from the conducted tests on the raw materials and the final products - white strawberry jam and white strawberry and *Chaenomeles* jam - are presented in Figures 1, 2, 3, 4, and Table 1.

The physicochemical analysis of the two developed jams indicates that the soluble and insoluble dry matter content shows no statistically significant difference ($p > 0.05$), with values exceeding 65% and 75%, respectively (Figure 1). These values meet the minimum permissible dry matter content for this type of product (not less than 60%).

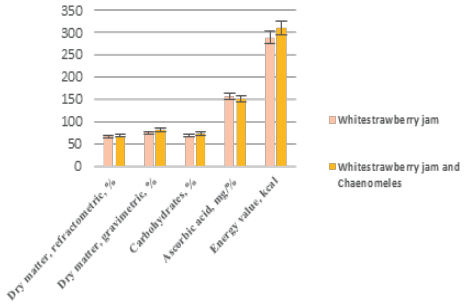

Figure 1. Physicochemical indicators of white strawberry products and white strawberry and *Chaenomeles*

Through the technological step of acidity correction - using citric acid for the first variant (white strawberry jam) and the natural acidity of *Chaenomeles* for the second variant (white strawberry and *Chaenomeles* jam) - the final products achieve an active acidity level above 4.15 (Figure 2).

With the applied sterilization regime at this acidity level, a microbiologically safe product is obtained, as confirmed by the results of the microbiological tests.

Water activity and the microenvironment within food influence bacterial growth and enzymatic processes. Most bacteria thrive within a water activity range of 0.90-1.00, yeasts at 0.94, and molds at 0.80-0.85. In the developed jams, the water activity value is above 0.71, which suggests an absence of bacterial, mold, and yeast growth (Figure 2).

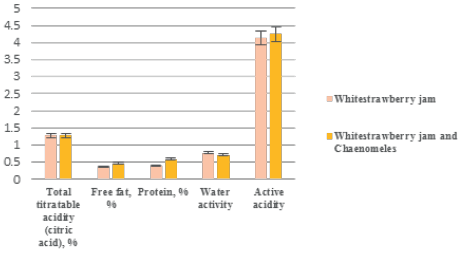

Figure 2. Biochemical indicators of white strawberry products and white strawberry and *Chaenomeles*

When analyzing the color characteristics of the products, only the red color tone parameter showed statistically indistinguishable values above 10 ($p > 0.05$).

Due to the composition of the products and the specific color of the fruits, the brightness parameter is higher in the white strawberry and *Chaenomeles* jam compared to the white strawberry jam. A comparative analysis shows that in terms of yellow color tone and qualitative color parameters - color saturation and hue - the values in the white strawberry jam are higher compared to the white strawberry and *Chaenomeles* jam (Figure 3).

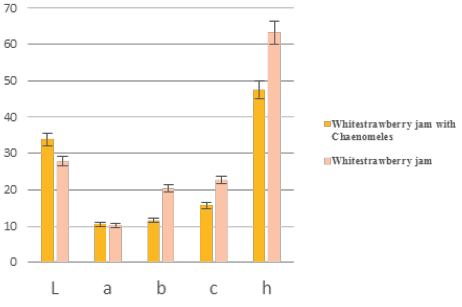

Figure 3. Color indicators of white strawberry products and white strawberry and *Chaenomeles*

The results of the biochemical indicators for the two developed products showed that the values for total carbohydrates (over 68%), acidity (1.28%), ascorbic acid (over 151 mg%), and energy value (over 289 kcal) were statistically indistinguishable from each other ($p > 0.05$) (Figures 1 and 2). Due to the specific chemical composition of *Chaenomeles*, slightly higher values were found in the white strawberry and *Chaenomeles* jam compared to the white strawberry jam for the fat and total protein indicators, with values of 0.47% and 0.59%, respectively (Figure 2).

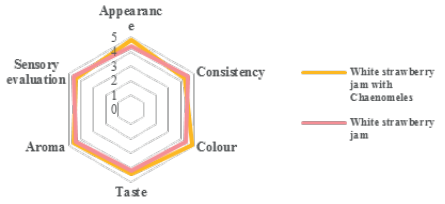

Figure 4. Sensory indicators of white strawberry products and white strawberry and *Chaenomeles*

Figure 4 presents the average ratings from the sensory tests conducted on five indicators – appearance, consistency, color, taste, and aroma of the two developed products, provided by trained tasters. For both assortments of white strawberry jam and white strawberry and *Chaenomeles* jam, the average ratings for the above-mentioned indicators were found to be above 4, statistically different ($p<0.05$), with the only exception being the consistency indicator, where the white strawberry jam received a higher rating. The maximum average ratings were for appearance and color, with the white strawberry and *Chaenomeles* jam scoring 4.82 and 4.86, respectively. The specific taste and aroma of *Chaenomeles* fruit, when used as a component in the white strawberry jam, enrich the sensory perception of the innovative product. The sweet-sour aftertaste of the white strawberry and *Chaenomeles* jam was preferred by the tasters compared to the white strawberry jam.

The data from the microbiological indicators of the developed products, analyzed in the Department of Microbiology at UHT, are presented in Table 1.

The table shows that no mesophilic anaerobic microorganisms were detected, and mesophilic aerobic and facultative anaerobic microorganisms, molds, and yeasts were below the established limits, respectively 100 cfu/g and < 10 cfu/g (Methodological guidelines for national microbiological criteria for food products not covered by EU Regulation 2073/2005 and EU Regulation 1441/2007). The applied pasteurization regime for the developed products guarantees their safety and quality.

Table 1. Microbiological indicators of white strawberry jam and white strawberry and *Chaenomeles* jam

Indicators	White Strawberry Jam	White Strawberry and *Chaenomeles* Jam
Mesophilic aerobic and facultative anaerobic microorganisms, cfu/g	<10	<10
Mesophilic anaerobic microorganisms, absence in 1 g	Not detected	Not detected
Molds and yeasts, cfu/g	<10	<10

CONCLUSIONS

Products made from white strawberry (*Fragaria* × *ananassa* 'Snow White') and a combination of white strawberry (*Fragaria* × *ananassa* 'Snow White') and quince (*Chaenomeles* sp.) have been developed, aiming to demonstrate the technological potential of using white strawberry fruits in products for mass consumption and as ingredient compositions in the bakery and confectionery industries.

It was found that the innovative products have high sensory scores, meeting the requirements of the Regulation on the specifications for fruit jams, jellies, marmalades, jelly-marmalades, and sweetened chestnut puree, adopted by Decision No. 45 from 21.02.2003, published in the Official Gazette No. 19 on 28 February 2003. These products are safe, of good quality, and suitable for consumption and inclusion in other products.

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REFERENCES

Brand-Williams, W., M., Cuvelier, C., Berset. (1995). Use of a Free Radical method to evaluate antioxidant activity. *Food Science and Technology-LebensmittelWissenschaft and Technologie*, 28(1), 25–30.

Chakhovsky, A., D., Shapiro, I., Chekalinskaya, E., Boboreko, N. Pankao. (1986). *Perspektivnie plodovo-yagodnie rastenia Belorosii*. [Promising fruit and berry plants of Belarus] (2nd ed.). Minsk:Belarus: Harvest

Cirico, T., S., Nyquist, M., Ferruzzi, B., Schweigert. (2006). Antioxidant Activity of Strawberry Phenolics. *Journal of Agricultural and Food Chemistry*, 54(3), 826–834.

Galli, R.L., B., Shukitt-Hale, K., Youdim, J., Joseph. (2006). Neuroprotective Effects of Strawberry Extracts. *Neuroscience Letters*, 398(1–2), 83–88.

Hellin, P., R., Vila, M.J., Jordan, J., Laencina, K., Rumpunen, J.M., Ros (2003). Characteristics and composition of Chaenomeles fruit juice. I/In: Japanese quince - Potential fruit crop for Northern Europe. *Swedish University of Agricultural Sciences, Alnarp, Sweden*, 127–140.

Krasnova I., S., Ruisa, D. Seglina (2007). Investigations on biochemical composition of *Chaenomeles japonica* fruits. *Cheminė technologija*. 4(46), 16–20.

Kumpan, V., S. Suhotskaya. (2010). *Chaenomeles yaponskii – novaya kultura v Zapadnoi Sibiri*. [*Chaenomeles* new crop in Western Siberia]. Omsk, RU: Omsk State Agrarian University Publishing House.

Mezhensky V.N. (1989). Economical and biological features of Chaenomeles (*Chaenomeles* Lindl). Synopsis of thesis, VIR, Leningrad 1–18.

Mihova T., V., Kondakova, P., Mondeshka. (2012). Investigation of *Chaenomeles japonica* Lindl. in the region of Central Balkans. *Banat's Journal of Biotechnology*, 3(6), 43–48.

Mondeska, P. (2005). *Lechebni plodovi rastenia.* [Medicinal fruit plants]. Sofia BG: Zemindat

Karakaya, S., S. El, N., Karagözlü, (2004). Anti-inflammatory Properties of Strawberry Polyphenols. *Phytotherapy Research*, 18(3), 201–209.

Markovic, J., T., Majkic, S., Popovic, I., Novakovi., (2000). Anticancer properties of strawberry phenols. *Journal of Nutritional Biochemistry*, 11(6), 357–364.

Moyer, R.A., (2002). Study on phenolic compounds in strawberries. *Nutrition Reviews*, 60(6), 260–263.

Petrova, V. (1987). *Diskorastushtie plodi i yagodi.* [Wild fruits and berries]. Moscow, RU: Forestry industry

Ramirez-Tortosa, M.C., S., Granados, J. L., Quiles. (2001). Chemopreventive properties of strawberries. *Journal of Nutritional Biochemistry*, 12(7), 430–436.

Singleton, V., J., Rossi. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. *American Journal of Enology and Viticulture*, 16, 144–158.