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INVESTIGATION OF WATER SOLUBLE SUGAR CONTENT AND FLAVOUR EVALUATION OF GALA MUST, ROYAL GALA AND PINOVA APPLE VARIETIES

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ABSTRACT
Humankind has known regular consumption of apple since ancient times. The fruits contain several bioactive compounds for human. Nowadays, a lot of breeded varieties are in cultivation on the world. There are more than 7,500 known cultivars of apples, resulting in a wide range of desired characteristics. The Gala series apples are one of the most popular and common apples in Hungary in the 21st century. Gala Must was used as the subject of a study to compare the fruit quality of Hungarian Gala Must with Pinova and commercially available Royal Gala apples. By studying the data recorded and samples collected in the orchard, the following points were studied and its cultivation in the Szentes region of Hungary is described: total sugar concentration, firmness, colour of fruits in biological ripening status and opinion of consumers. Based our results the water soluble sugar content of Gala Must 15; Pinova 13.8; Royal Gala 14.1 BRIX%.

Keywords: (*Malus domestica* Borkh.), Gala Must, Pinova, Royal Gala, water soluble sugar concentration BRIX (%)

INTRODUCTION

The apple is (*Malus domestica* Borkh.) one of the most popular fruit in many countries (TANÁCS 2005). The apple found in the scriptures in the Garden of Eden is most likely a pomegranate, which also symbolically contained the 613 commandments of the world (RÓNA 2021). It belongs to genus *Malus* in the *Rosaceae* plant family, sub family *Pomoideae*, which includes crop species such as pear, rose and quince. When cultivated, the size, shape and branch density are determined by rootstock selection and trimming method. Its flowers are white with flushing, about 3 to 5 cm in diameter. Both the pedicel and the calyx have off-white downy (QIAN ET AL. 2006). Most varieties are self-sterile and 5 need to plant pollinator trees. The inflorescence consists of a cyme with 4-6 flowers. Many apples require cross-pollination between individuals by insects (typically bees, which freely visit the flowers for both nectar and pollen); these are called self-sterile, and therefore self-pollination is impossible, making pollinating insects essential (WILSON and ELFING, 2013; HARRISON and HARRISON 2011). Apple fruits have high nutritional value, rich in minerals, vitamins, and calcium, which help metabolize excess salt in the human body (LANTOS, 2008). Many varieties are relatively high in sugar, only mildly acidic, and very low in tannin. Apples provide vitamins A and C, are high in carbohydrates, and are an excellent source of dietary fibre (*Table 1*.) (KOUTSOS and LOVEGROVE 2015). The largest exporters of apples are China, Italy, Chile, the United States, and Poland, while the biggest importers in the same year were Russia, the United Kingdom, Iraq, the Netherlands, and Spain. The world crop of apples averages more than 60 million tons a year, the vast majority of which is produced by China however 500 thousand tons by Hungary (AUGUSTYN 2021).

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The aims of our work were:

- the test of total sugar concentration of the ripened Gala Must apple fruits compared with Pinova and Royal Gala varieties in colleration of similar growing technology,
- analysis of the cultivation method,
- flavour assessment and market analysis.

Table 1. Main nutritional components of apples in 100g fresh material

Nutrition	value
iron	0.1 g
magnesium	13.8 g
calcium	10.3 g
vitamin B1	2.4 g
vitamin B2	0.1 g
vitamin K	0.2 g
vitamin E	4.6 mg
vitamin A	3 µg
ß-carotene	27 µg
vitamin C	0.1 mg
protein	2.2 µg
fat	0.01 mg
fiber	0.02 mg
total sugar	**6 mg**
carbohydrates	5 mg
energy	218 kJ

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MATERIALS AND METHODS

A study of the Gala must apple variety was carried out in Szentes, Hungary on 2020. It is located in the southern part of Csongrád-Csanád County, in the northern part of the county, east of the Tisza River. The orchard is planted with a large number of 4-8 year old fruit trees of the varieties Red Delisious, Golden Delisious, Pinova and Gala Must varieties.

Climatological data of Szentes

Hungary experiences a continental climate in the east, maritime climate in the west and a Mediterranean maritime climate in the south. In general given the average temperatures and precipitation, it corresponds mostly to a continental climate. That means warm summers and cold winters. The Szentes temperature basically comes down to the following: The average temperatures in May, June, July, August and September are optimal. On average, August is the warmest month but on average, January is the coolest month.

The annual average maximum temperature is 16.0°C. The annual average minimum temperature is 5.0°C. Hours of sunshine in Szentes, basically comes down to the following: average, July has the greatest amount of the sunshine but December has the least amount of one. The rainfall in Szentes basically comes down to the following: June is the wettest month. February is the dryest month. Annual average precipitation: 495.0 mm.

The studies material

The orchard was planted with several 4 year old Gala Must apple trees. Three Gala Must and three Pinova were randomly picked in situ at the study site in Szentes. The plants were recorded and photographed, and the site was photographed for pest infestation and environment. Records of nutrient availability and manual handling during planting, fruit set and harvest.

Several fresh Gala Must apples and Pinova apples were collected as raw material for the experiment. Multiple sets of data were collected for comparative analysis. The experiments were carried out using a refractometer to determine the sugar content within the samples. Principle of data collection; Refraction occurs when light enters a medium from one medium to another. The ratio of the angle of incidence sine is a constant value and this ratio is called the refractive index. Fruit and vegetable juices in soluble solids content and refractive index in certain conditions (the same temperature, pressure) is proportional, so the determination of the refractive index of fruit and vegetable juices, fruit and vegetable juices can be derived from the concentration (the amount of sugar).

Studying method

Fruit size measurement: three Pinova and three Gala Must apples were picked at random. Use a tool ruler to measure the diameter of the apples. For subsequent comparative analysis. *Colouring measurement*: three Pinova and three Gala Must apples were picked at random. The red and yellow-green parts of the fruit surface were divided and the proportion of the surface area of the apples was calculated separately for each colour block.

Recorded observations on the profile: two ripe Gala Must apples were selected and cut longitudinally and horizontally using a knife. Record the structure of the sections.

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Equipments

The experiments were carried out using a HI 96801 refractometer to determine the sugar content within the samples. The ratio of the angle of incidence sine is a constant value and this ratio is called the refractive index.

- **Nutrient supply in different periods**

The most important period for growing of apple species is from flowering to harvest.

Table 2. Nutrient supply in difference period

Period	nitrogen (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	micro-elements (kg/ha)
flowering	45	5	15	B, Ca
fruiting	20	20	20	B, Ca
colouring	5	15	45	B, Ca

Planting method

The planting method was intensive cultivation. Round based, spool shaped crown, M9 special rootstock were applicated.

RESULTS

Comparison and analysis of shapes and colours

From the test data we can see that Gala Must has the highest total average sugar content in this batch. One of the Gala Must apples in Group 1 had a very high value. By looking at the source of the sample, the remaining half of the apple and its data, I found that this one apple was more saturated and redder in colour and slightly larger in diameter than the other apples.
Similarly, I looked at the data and the source of the Pinova apple from Group2. However it was not significantly different from the other apples. The skin surface was much rougher and had small brown spots. After comparing the data, the Gala Pinova collected from the research orchard performed better than the Royal gala and Pinova in terms of sugar content. They had better quality (*Table 4*).

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Table 3. Characters of the matured apple varieties

Variety name	**Gala Must**	**Pinova**	**Royal Gala**
Origins	Research orchards	Research orchards	Market purchases
Harvest/availability	1/3 of September. Stored until May	3/3 of September. Stored until the beginning of July	1/3 of September. Stored until May
Fruit diameter Average	70-80mm	70-80mm	60-75mm
Coloration rate	bright orange-red with a yellowish base	yellowish base, covered with a 70% distinctive orange-red streak	yellow to orange skin, highlighted with pink to red stripes
Colour	70%+	70%+	70%+
Hardness	normal	hard	hard
Photo	 	 	 
Ten tasters' vote on colour liking	4	2	4

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Comparison and analysis of sugar content of fruits

Table 4. Sugar content of the apple varieties

Sugar content test				
Temperature **22.8°C**		**Variety name**		
Unit **°Bx**	Number	**Gala Must**	**Pinova**	**Royal Gala**
Group 1	1	16,0	14,8	13,9
	2	15,9	14,3	14,1
	3	15,8	14,5	14,0
	avg.	15,9	14,5	14,0
Group 2	4	14,8	13,0	15,2
	5	14,1	12,7	14,5
	6	14,4	12,8	14,8
	avg.	14,4	12,8	14,8
Group 3	7	14,0	13,9	13,5
	8	14,9	14,1	12,9
	9	14,9	14,0	13,8
	avg.	14,6	14	13,4
Total average		**15,0**	13,8	14,1

Table 5. Flavour evolution of the fruits

Flavour Evaluation Form Statistics							
Variety name	No.	Colour (avg.)	Sweetness (avg.)	Hardness (avg.)	Fragrance (avg.)	Combined flavours (avg.)	Buy or not (Buy unit person)
Gala Must	1	**5**	**5**	4	3	4	5
	2	4	4	3	3	3	4
	3	4	4	4	4	**5**	**8**
Pinova	4	4	4	3	4	4	**7**
	5	3	3	4	3	4	4
	6	3	4	3	4	4	6
Royal Gala	7	4	4	4	3	4	7
	8	**5**	4	4	4	**5**	**8**
	9	4	3	4	3	4	6
Evaluation on a scale of 1-5, the higher the quality of the score the better. 1 - Poor, 2 - Fair, 3 - Average, 4 - Good, 5 - Excellent							

DISCUSSION

Our paper focuses on the cultivation and breeding of Gala Must in Hungary, as well as comparing the taste and sweetness ratings of Gala Must, Royal gala and Pinova. Gala apples are distinctive for their sweetness, colour and flavour. These points make it stand out from many other apples. As the share of Gala apples increases, more orchards are willing to grow Gala apples and more farmers are willing to select and cross more new varieties. So the future of Gala apples in Europe should be increasingly promising. In

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addition, the apple market should be gradually cleared of low-yielding, low-quality apple varieties. Gradually replace them with high quality apples to complete the market. Tests and data show that Gala Must also has a very high sugar content. Some farms have previously stated in their sales information that Gala Must has a sugar content of between 12 and 14°Bx. In fact, the samples collected were experimentally measured to have higher values. Of course, this is also related to the growing techniques and the local climate. In terms of flavour, Gala Must has a very high sweetness.

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