Experimental results of the effects of Hungarian climatic conditions to German disease-resistant industrial apple varieties

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Abstract: In the recent years, several disease-resistant apple varieties appeared through the modern breeding technologies. These varieties can be grown with low usage of pesticides, which mean not only environment friendly fruit growing, but the production costs are also lower. In Eastern-Hungary – it is one of the main apple growing regions – a new apple growing structure started to form by the investment of the German Wink Ltd. – several resistant apple varieties were brought from Germany. 'Resistant' refers genetic resistance that usually transferred from the genome of wild apple species. But the fruit of these apple species is not only resistant to diseases, but its quality is poorer, too. In Germany the Re-apples are grown only for the processing industry. Due to climatic circumstances in Eastern Hungary, the first experiences showed better parameters during laboratory measurement, the fruits have more beautiful view, shape and inner characters than usual industrial apples.

In our paper we discuss the results of sensory (consumer) tests, carried out in Eastern Hungary and in the Budapest-region the data analysis of systematic storing experiments (refraction, flesh firmness, weight loss, etc.) and profile analysis of fresh and stored Re-apples. (In the profile analysis the ProfiSens software [4,5] has been used.)

Key words: Chemical and biological properties of Re-apples, Effects of Hungarian climatic conditions, Food Sensory Testing

Introduction

Apple has a considerable importance in processing industry and it is one of the most important fruits in Hungarian horticulture, as well. In the past 15 years, many changes took place in the structure of Hungarian apple growing. Large orchards were usually split to smaller parts, and the former largest market – the former Soviet Union – does not exist any more. Under these circumstances, a lot of factors should be investigated before introducing a new variety to the Hungarian market. For resistant apple varieties mean a lower environmental burden in growing, and therefore higher food safety, we have investigated several properties of Re-apples grown in Hungary, including chemical analysis and sensory testing for both fresh and stored fruits.

Re-apples in Hungary

In Eastern Hungary (one of the main apple growing region), a new apple growing structure started to form in 1999 by the investment of Wink Ltd. Several resistant apple varieties were imported from Dresden-Pillnitz, Germany. At the very beginning, the goal was to assure the row material for the apple-processing industry, using varieties that have a content of high value, guarantee large yields and are disease-resistant, moreover, suitable for mechanical harvest. Re-apples have all these advantages, they have genetic resistance against many diseases, and they are not modified genetically [*Work* et al., 1994, *Zech*, 1989].

The varieties (*Reanda, Reglindis, Releika, Relinda, Remo, Renora, Resi* and *Rewena*) were tested regularly; compared with *Jonathan*, the most preferred apple variety of the region, for the microclimate of Hungary develops special taste- and aroma characters in different apple varieties of the world. (As shown, we didn't use *Jonathan* in tests made at Nyírmada because most of the panellists, or assessors, there were growers, who had plenty of information about this variety.)

Sensory tests of Re-apples

In the autumn of 2002, we started to investigate the popularity of Re-apples in the frame of the East- Hungarian Apple-days at Nyíregyháza and Csenger, and on the Hortus Hungaricus nationwide exhibition at Szigetszentmiklós (near Budapest). In consumer tests, we have used the ranking method with complementary questionnaires about the distribution (represented set) of assessors [ISO/CD2, 2000]. As tools of evaluation for the numerous answers summarized

in *Table 1*, we have used our own software developed for our Internet – based questionnaires [*Kápolna* et al., 2002, *Kollár* et al., 1999]

The assessors usually investigated taste and appearance of six three-digit coded apple varieties – five Re-apples and *Jonathan* (the most preferred apple variety in Hungary). On the back page of the questionnaire-sheet they answered the personal questions about age, job, sex, frequency of consuming apple, requests about product information, preferred varieties or habits of shopping [*Kápolna* et al., 2002].

We published our experiences about the year 2002 in the proceedings of two conferences [*Kókai* et al., 2002, 2003], here we mention only the fact, that although the assessors in 2002 didn't mention any Re-apple among the most preferred apple varieties, they ranked considering both, tasting and appearance, in every region either a Re-apple as first, or – if the first variety was the *Jonathan* (appearance at Csenger and on the Hortus for one series) – then there was no significant difference between the first *Jonathan* and second Re-apple.

In the following tables, where we evaluate the ranking tests by cluster analysis, the Shaded-Bold-Italic highlighting will mean –similarly to the *Table 4* – no significant difference from the first ranked variety.

Using Laboratory sensory tests – profile analysis carried out by trained assessors – the five Re-apple varieties and the *Jonathan* have shown a similarity on high level [*Kókai* et al., 2002]. We show an example in *Figure 1* about eleven attributes: flesh's green, white, yellow colour, flesh's hardness and juiciness, peel, flesh's sweet and sour taste, odour, aroma, taste and aroma together (on the Figure clockwise, starting at "noon").

At Nyírmada, we have tested five varieties of Re-apples only.

Table 1 Number of answers/assessors for consumer tests of 2002–2003 in different regions/events

Region/event and year	Number of assessors
HH (Hortus Hungaricus), 2002	418
NY (Nyíregyháza), 2002	119
CS (Csenger), 2002	70
HH (Hortus Hungaricus), 2003	461
HH (Nyíregyháza), 2003	214
NYM (Nyírmada), 2003	77

Table 2 Age, sex and job distribution of assessors in 2002–2003 in different regions/events

Event	Age%			Sex%		Job%		
	25	40	ab	M	F	int	mn	st
HH2002	24	20	56	31	69	58	23	19
NY2002	16	24	60	34	66	62	23	15
HH2003	25	22	53	30	70	57	21	22
NY2003	32	16	52	37	63	53	17	30
NYM2003	29	31	40	38	62	50	29	21

ab=above 40; int=intellectual; mn=manual; st=student

Table 3a First and second apple varieties in ranking tests of 2002 in different regions/events (all assessors)

Event	Taste		Appearance	
	first	second	first	second
HH	Releika	Jonathan	Jonathan	Remo
HH-N	Remo	Rewena	Remo	Jonathan
NY	Releika	Reglindis	Remo	Reglindis
CS	Remo	Reanda	Jonathan	Remo

HH-N=ranking without 3-digit sample codes, but by name on Hortus

Table 3b First and second apple varieties in ranking tests of 2003 in different regions/events (all assessors)

Event	Taste		Appearance	
	first	second	first	second
HH	Jonathan	Releika	Rewena	Jonathan
NY	Releika	Resi	Remo	Rewena
NYM	Releika	Resi	Reanda	Resi

Table 4 Cluster analysis of Taste-ranking on Hortus Hungaricus 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties					
all	***Jon***	***Rel***	***Res***	Rew	Rem	Reg
men	***Res***	***Jon***	***Rel***	Rew	Rem	Reg
women	***Jon***	***Rel***	***Res***	Rew	Rem	Reg
age (–25)	***Jon***	***Res***	Rew	Rel	Rem	Reg
age (26–40)	Jon	Rel	Res	Rew	Rem	Reg
age (41–)	***Rel***	***Res***	***Jon***	Rew	Reg	Rem
job (intel)	***Jon***	***Res***	***Rel***	Rew	Rem	Reg
job (manual)	***Rel***	***Jon***	***Res***	***Rew***	Reg	Rem
students	***Jon***	***Res***	Rel	Rew	Rem	Reg

Shaded-Bold-Italic highlighting means no significant difference from first ranked variety

Table 5 Cluster analysis of Taste-ranking at Nyíregyháza 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties					
all	***Res***	***Rel***	Jon	Rem	Reg	Rew
men	***Res***	***Rel***	Jon	Rem	Reg	Rew
women	***Res***	***Rel***	Reg	Jon	Rem	Rew
age (–25)	***Rel***	***Res***	Rem	Jon	Rew	Reg
age (26–40)	Rel	***Res***	***Rem***	Jon	Rem	Reg
age (41–)	***Res***	***Rel***	***Reg***	Jon	Rem	Reg
job (intel)	***Res***	***Rel***	Jon	Rem	Reg	Rew
job (manual)	***Rel***	***Reg***	***Res***	***Rem***	Jon	Rew
students	***Res***	***Rel***	Rew	Rem	Jon	Reg

Table 6 Cluster analysis of Appearance-ranking on Hortus Hungaricus 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties					
all	***Rew***	Jon	Reg	Res	Rem	Rel
men	***Rew***	Jon	Res	Reg	Rem	Rel
women	***Rew***	Jon	Reg	Res	Rem	Rel
age (–25)	Rew	***Jon***	Reg	Res	Rem	Rel
Age (26–40)	Rew	***Jon***	***Reg***	***Res***	Rem	Rel
age (41–)	***Rew***	Jon	Res	Reg	Rem	Rel
job (intel)	Rew	Jon	Res	Reg	Rem	Reg
job (manual)	***Rew***	Jon	Res	Jon	Rem	Rel
students	***Rew***	Res	Reg	Res	Rem	Rel

Table 7 Cluster analysis of Appearance-ranking at Nyíregyháza 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties					
aall	*Reg*	*Jon*	Rew	Rem	Res	Rel
men	*Res*	*Jon*	Res	Rew	Rem	Rel
women	*Reg*	*Jon*	*Rew*	*Rem*	Res	Rel
age (–25)	*Rem*	*Jon*	Rew	Reg	Res	Rel
age (26–40)	Rew	*Reg*	*Res*	*Jon*	*Rem*	*Rel*
age (41–)	*Reg*	Jon	Res	Rew	Rem	Rel
job (intel)	*Reg*	*Jon*	Rew	Res	Rem	Rew
job (manual)	*Reg*	Rew	Jon	Res	Rem	Rel
students	*Rem*	*Jon*	Rew	Reg	Res	Rel

Table 8 Cluster analysis of Taste-ranking at Nyírmada 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties				
all	*Rel*	*Res*	Rea	Rew	Rem
men	*Rel*	*Rea*	Res	Rew	Rem
Women	*Rel*	*Res*	*Rew*	*Rea*	Rem
age (–25)	*Rew*	*Rel*	*Res*	*Rea*	*Rem*
age (26–40)	*Rea*	*Rel*	*Res*	Rew	Rem
age (41–)	*Rel*	*Res*	Rew	Rea	Rem
job (intel)	*Rel*	*Res*	Rew	Rea	Rem
job (manual)	*Res*	*Rel*	*Rea*	*Rew*	Rem
Students	*Rew*	*Rem*	Rel	*Res*	*Rea*

Table 9 Cluster analysis of Appearance-ranking at Nyírmada 2003 with respect to assessor's sex/age/job

Cluster	Ranking apple varieties				
all	*Rea*	*Rem*	*Rew*	Res	Rel
men	*Rea*	*Rem*	*Rew*	Res	Rel
women	*Rea*	*Rew*	*Rem*	Res	Rel
age (–25)	*Rew*	*Rem*	*Rea*	Res	Rel
age (26–40)	*Rea*	Rem	Rew	Res	Rel
age (41–)	*Rea*	*Rem*	*Rew*	Res	Rel
job (intel)	*Rea*	*Rew*	*Rem*	Res	Rel
job (manual)	*Rea*	*Rem*	Rew	Res	Rel
students	*Rem*	*Rew*	Rea	Res	Rel

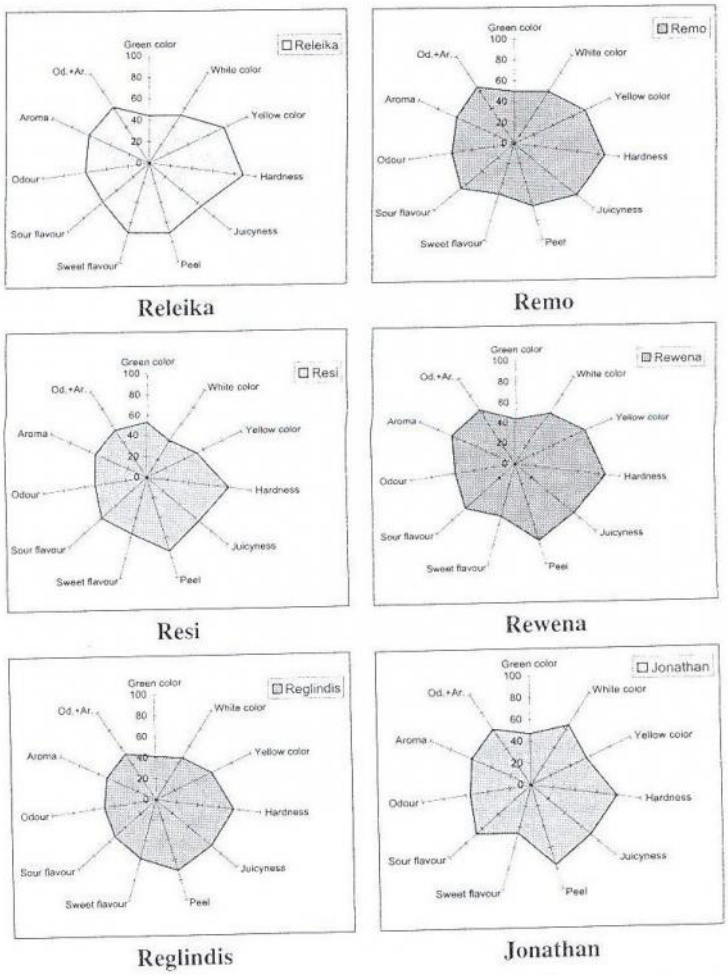

Figure 1 Apple profile analysis results given by ProfiSens software

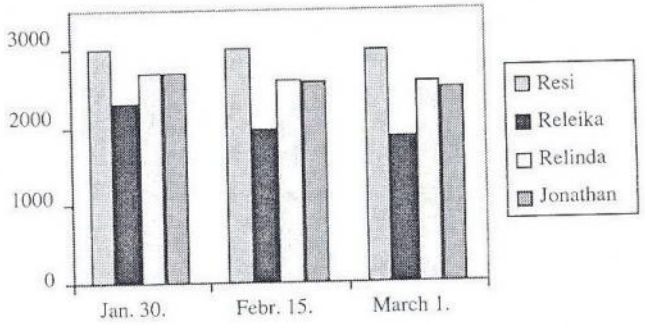

Figure 2 Changes of flesh firmness in stored Re-apples and Jonathan (measured at T=6 °C) [kPa/Nmm]

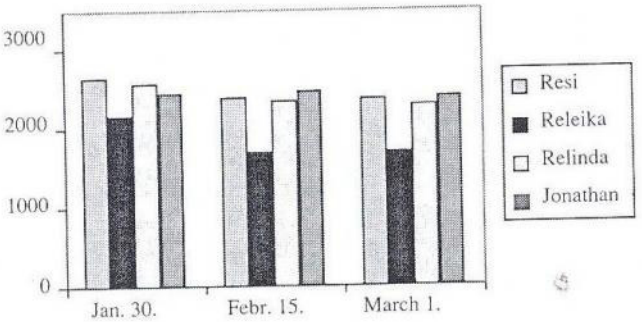

Figure 3 Changes of flesh firmness in stored Re-apples and Jonathan (measured T=20 °C [kPa/Nmm]

Experiences in storability

We have stored six different Re-apples and the Hungarian favourite Jonathan variety from October to March at the usual conditions (T=3 °C, relative humidity=90%). *Remo*, *Rewena* and *Reanda* weren't well storable. For the three well storable resistant varieties, *Releika*, *Relinda Resi*, and for the *Jonathan* (test) variety we measured the most important attributes fortnightly, starting in January. The attributes that have decisive influence on the value of apples are the following [*Henze* et al., 2002]:

- Flesh firmness
  - at T=6 °C (transportability)
  - at T=20 °C (shelf life)
- Weight and rotting losses
- Refraction

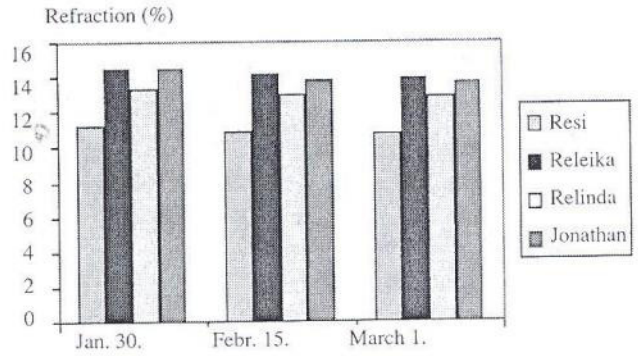

Figure 4 Changes in refractometric values of stored apples

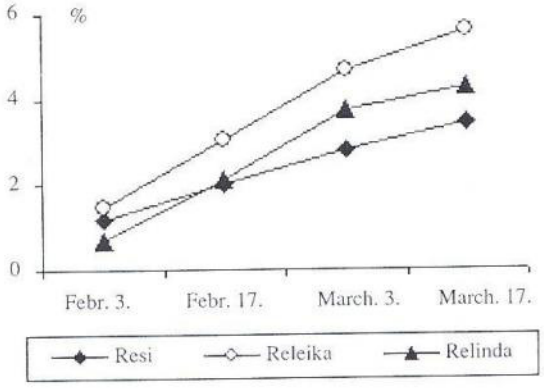

Figure 5 Weight loss in stored Re-apples

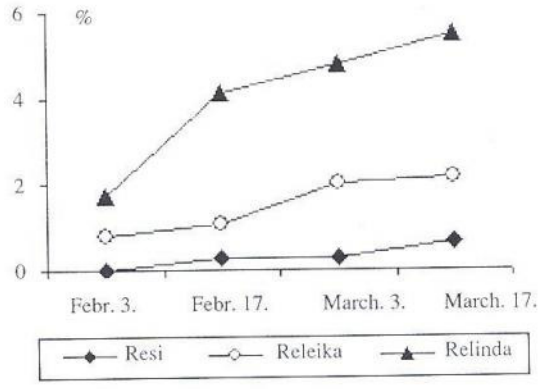

Figure 6 Rotting loss in stored Re-apples

Discussion

Resistant Apple varieties grown under climatic conditions of Hungary – as proved by our experiences – are equivalent to – and in some cases better than – the favourite *Jonathan* variety, according to sensory and storing tests, as well.

By assuring and distribution of proper nursery material of Re-apple varieties, their share on the market will increase, significantly, let alone a serious decrease of environmental pollution.

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List of Symbols

ab	Age: above 40
BUTE	Budapest University of Technology and Economics
BUESPA	Budapest University of Economic Sciences and Public Administration
CS	Csenger
HH	Hortus Hungaricus
HH-N	Ranking without 3-digit sample codes but by name on Hortus Hungaricus exhibition
int, intel	Job: intellectual
mn	Job: manual
NY	Nyíregyháza
NYM	Nyírmada
st	student
Re-apple	Disease-resistant apple variety
Rea	Reanda
Reg	Reglindis
Rel	Releika
Rem	Remo
Res	Resi
Rew	Rewena
VBA	Visual Basic for Application

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