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ORIGINAL ARTICLE

Sensory Acceptability of the Autochthonous Fruits of Bosnia and Herzegovina

Challenges and Possibilities for Food Industry

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Abstract
Introduction and background: Autochthonous fruits in Bosnia and Herzegovina (B&H) represent great opportunities for fruit breeding, because they could be grown without costly agricultural inputs and offer valuable assets for the fruit processing industry providing a specific and different sensory taste for the fruit products. Hence, the objective of this study was to sensory evaluate fruits from 34 autochthonous apple and 29 pear cultivars in 2012 and 2013 from an *ex-situ* collection in B&H by eight trained panelists, using Quantitative Descriptive Analysis (QDA).
Experimental: Flavour of fruits was described by the eight sensory attributes a) flavour: odour intensity, b) sweet, c) sour, d) green, fruit, e) floral flavour, f) typically, g) after taste and h) overall conception and subjected to principal component analysis (PCA) to visualise the sensory attributes.
Results: For apple, the traditional cvs. 'Prijedorska Zelenika', 'Paradija', 'Srebrenička', 'Bukovija' and 'Ljepocvijetka' reached the best flavour scores in both years, while in pear, cvs. 'Takiša', 'Hambarka', 'Dolokrahan' and 'Kačmorka' exhibited the best flavour in both years, followed by cvs. 'Begarika', 'Jeribasma', 'Ahmetova' and 'Hambarka' with intense floral flavour and odour. In these tastings, B & H grown apple cv. 'Golden Delicious' also scored highly compared with cvs 'Idared', 'Granny Smith' and 'Gala' with a lesser characteristic apple flavour and pear cvs 'Williams' and 'Sweet Harrow' scored better than 'Alexander Lukas' and 'Gellerts' from B & H.

Keywords Apple (*Malus domestica* L.) pear · Biodiversity · Consumer · Flavour · Pomology · Under-exploited fruit · Taste

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Sensorische Akzeptanz von alten Kernobstsorten aus Bosnien und Herzegowina

Herausforderungen und Chancen für die Lebensmittelindustrie

Zusammenfassung

Traditionelle Kernobstsorten aus Bosnien und Hezegowina (B & H) stellen nicht nur eine wichtige genetische Ressource für Pflanzenzüchter dar, sondern auch eine Chance für einen relativ extensiven Anbau mit geringem Aufwand. Diese traditionellen Apfel- und Birnensorten aus B & H bieten interessante Geschmacksnuancen für die obstverarbeitende Lebensmittelindustrie. Daher war das Ziel dieser Arbeit, diese alten Kernobstsorten geschmacklich zu untersuchen.
Material und Methoden: Dazu wurden Früchte von 34 alten regionalen Apfel- und 29 alten Birnensorten aus der Ernte in 2012 und 2013 mit Hilfe eines 8-köpfigen Geschmackspanels und der Quantitative Descriptive Analysis (QDA) untersucht. Der Geschmack wurde durch die 8 Parameter 1) Aroma bzw. Geruch, 2) Süße, 3) Säure, 4) Chlorophyllgeschmack (Grasnote), 5) blumiger Geschmack, 6) typischer Geschmack, 7) Nachgeschmack und 8) Gesamteindruck erfasst.
Ergebnis: In beiden Jahren (2012 und 2013) zeichneten sich die alten Apfelsorten 'Prijedorska Zelenika', 'Paradija', 'Srebrenička', 'Bukovija' and 'Ljepocvijetka' bei der Auswertung der Verköstigungsergebnisse mittels PCA durch einen guten Geschmack aus ähnlich wie die Sorten 'Takiša', 'Hambarka', 'Dolokrahan' and 'Kačmorka' bei Birnen, bei denen die Sorten 'Begarika', 'Jeribasma', 'Ahmetova' und 'Hambarka' 2012 gutes Aroma und blumigen Geschmack aufwiesen. In diesen Verköstigungen schnitten Apfelfrüchte der Sorte 'Golden Delicious' aus B & H geschmacklich besser ab als solche von 'Idared', 'Granny Smith' und 'Gala' sowie 'Williams' und 'Sweet Harrow' Birnen besser als 'Alexander Lukas' und 'Gellerts'.

Schlüsselwörter Apfel (*Malus domestica* L.) · Alte Apfelsorten · Birne · Aroma · Artenvielfalt · Biodiversität · Geschmack · Obstverarbeitung · Pomologie

Introduction

Traditional fruit cultivars from Bosnia and Herzegovina (B & H) represent an interesting genetic resource (Gasi et al. 2013a, 2013b, 2013c); Milosevic et al. (2010) emphasize the importance of protection and adequate use of these indigenous pome fruit cultivars. Increased consumption of fruit in B&H is evident, but as large not as hoped. Most studies that have investigated the importance of different sensory modalities on consumer acceptability conclude that flavour is the most important modality (Moskowitz and Krieger 1995 according to Kilcast and Fillion 2001). Fruit exhibit aromatic properties and therefore can be exploited as a flavouring for many foods.

As Mattiacci and Vignali (2004—according to Favalli et al. 2013) highlighted, for consumers, unique food products seem to have a distinctive and superior quality with respect to the general ones; thus producers can position their unique food products in the premium price range and gain a greater profit margin. In the last years, consumers' demand for unique food products has increased rapidly (Favalli et al. 2013). In the B&H fruit producer's view, autochthonous fruits offer a unique and distinctive quality, a challenge for the fruit processing industry. Autochthonous fruits could provide specific flavour and other chemical compounds such as antioxidants and vitamins and add value to many fruit products such as jam, juice and fruit distillates. Autochthonous fruits could hence give a unique touch to B&H products. Thus, the objective of this work is to investigate sensory quality of autochthonous fruits aimed at their appropriate use in the fruit processing industry.

Material and Methods

Thirty-four apple cultivars and twenty-nine pear cultivars were harvested in 2012 and 2013 at commercial harvest stage and kept at the ex-situ collection "Srebrenik" in Northeast Bosnia. Harvest time varied depending on fruit ripening time from the end of June to early November. Immediately after harvest, the fruit were transpored to our laboratory (Table 1 and 2).

Sensory Evaluation of Fruit

Quantitative Descriptive Analysis (QDA) was carried out with 8 panelists, who had been recruited from the staff of the Faculty of Agriculture and Food Science University of Sarajevo. The panelists were trained in the evaluation of apples and pears and in the use of fruit attributes.

During training, panelists agreed on a consensus list of the next eight attributes for sensory profiling of fruit flavour: odour intensity, sweet flavour, sour flavour, green fruity flavour, floral, typically, after taste, and overall sensation. Flavour attributes were rated using category scales from 1 = not detectable to 5 = extremely strong examined attributes. During the sensory session, each panelist analysed one fruit of each apple and pear cultivar.

Table 1 Apple cultivars harvested in 2012 and 2013

Apple Cultivars	*Petrovača*	*Mirisavka*	*Funtača*	*Bukovija*	*Tetovka*	*Masnjača*	*Ruzmarinka*	*Lederka*	*Senabija*	*Francuska kožara*	*Kanjiška*	*Prijedorska zelenika*
2012	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1
2013	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1
Apple Cultivars	*Ljepocvijetka*	*Dobrić*	*Rebrača*	*Srebreničk*	*Žuja*	*Paradija*	*Konjuha*	*Crvena petr*	*Stana*	*Habikuša*	*Bijela funtača*	*Pašinka*
2012	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	X 0
2013	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	X 0	X 0	X 0	X 0	X 0	✓ 1
Apple Cultivars	*Đulabija*	*Budimka*	*Bobovec*	*Šarenika tvrda*	*Sarija*	*Samoniklica*	***Granny Smith***	***Idared***	***Golden Delicious***	***Gala***	–	–
2012	X 0	X 0	X 0	X 0	X 0	X 0	✓ 1	✓ 1	✓ 1	✓ 1		
2013	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	X 0		

In bold are presented commercial cultivars
✓ harvested, *X* not harvested

Table 2 Pear cultivars harvested in 2012 and 2013

Pear Cultivars	*Kačmorka*	*Tikvenjača*	*Hambarka*	*Zelenika*	*Sarajka*	*Ahmetova*	*Budeljača*	*Duardova maslovka*	*Takiša*	*Krakača*	*Dolokrahan*
2012	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1
2013	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1
Pear Cultivars	*Crna Izmirka*	*Ljeskovača*	*Hasanagićka*	*Delkora*	*Zimnjača*	*Izmirka*	*Jeribasma*	*Okrugljača*	*Kaličanak*	*Urumenka*	*Huseinbegovićka*
2012	✓ 1	✓ 1	✓ 1	✓ 1	X 0	X 0	X 0	X 0	X 0	X 0	X 0
2013	✓ 1	✓ 1	X 0	X 0	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1
Pear Cultivars	*Ćopa*	*Viljamovka*	*Tikvenjača*	*Begarika*	***Williams***	***Gellerc***	***Sweet Harow***	***Aleksandar Lukas***	–	–	–
2012	X 0	X 0	X 0	X 0	X 0	X 0	X 0	X 0			
2013	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1			

In bold are presented commercial cultivars
✓ harvested, *X* not harvested

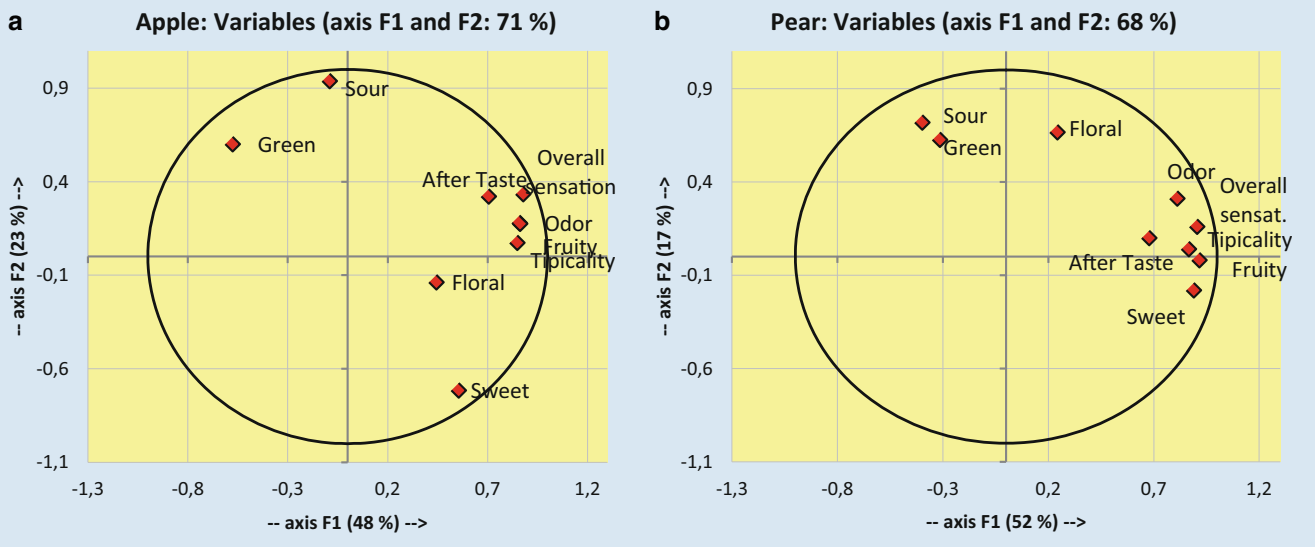
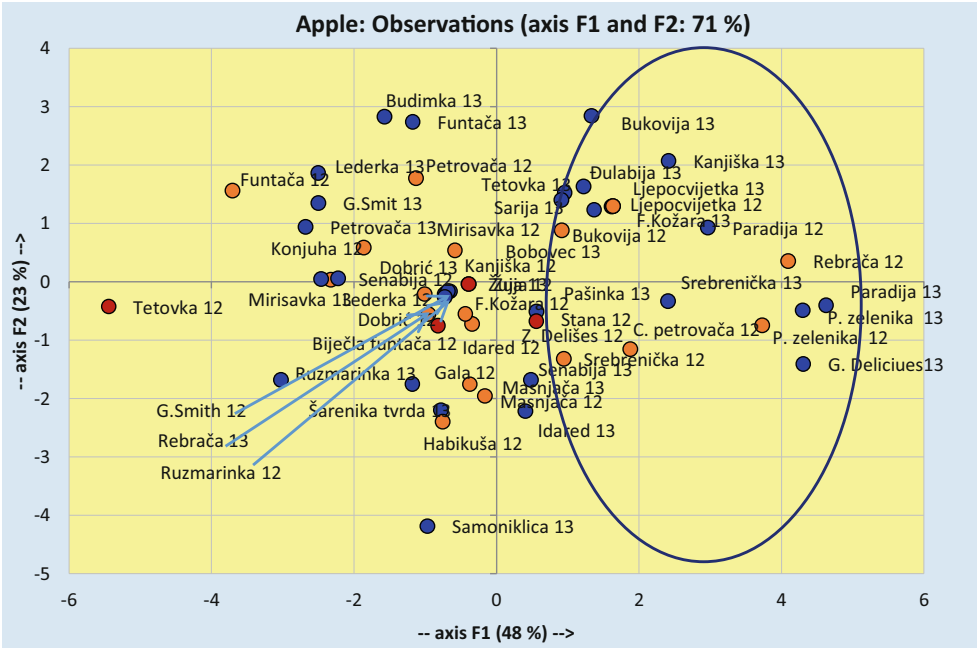


Fig. 1 Plot of sensory attributes for the apple cultivars (**a**) and pear cultivars (**b**)

Fig. 2 Plot of apple cultivars—cultivars in the circle exhibit particularly consistent positive fruit characteristics



Statistical Analysis

Mean values of intensity of sensory attributes for the different cultivars were subjected to Principal Component Analysis (PCA) of the corellation matrix, using Grimmer Soft programe—StatBox 6.7, France.

Results and Discussion

In the plot of sensory attributes, positive flavour attributes such as fruity, floral, odour intensity, typicality, after taste and overall liking are situated on the right side of PC1 according to their significance values of the Pearson correlation coefficient (standardize PCA) (Fig. 1a and 1b). Green and sour flavour attributes are on the opposite (left) side of PC1.

The position viz flavour of apple cultivars in the plot (Fig. 2) was affected by harvest date, but this is not currently sufficient for prediction of sensory attributes of fruit. The apple cultivars, which scored highly in 2012 and 2013 for most flavour attributes, were 'Prijedorska Zelenika', 'Paradija', 'Srebrenička', 'Bukovija' and 'Ljepocvijetka' (Fig. 4).

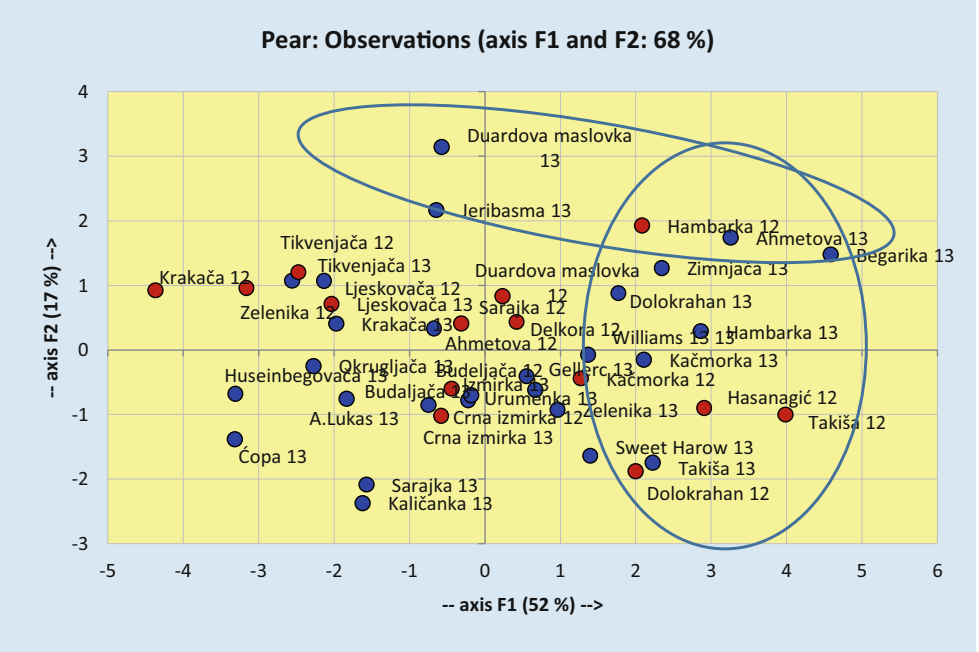


Fig. 3 Plot of pear cultivars—cultivars in the two circles exhibited particularly consistent positive fruit characteristics

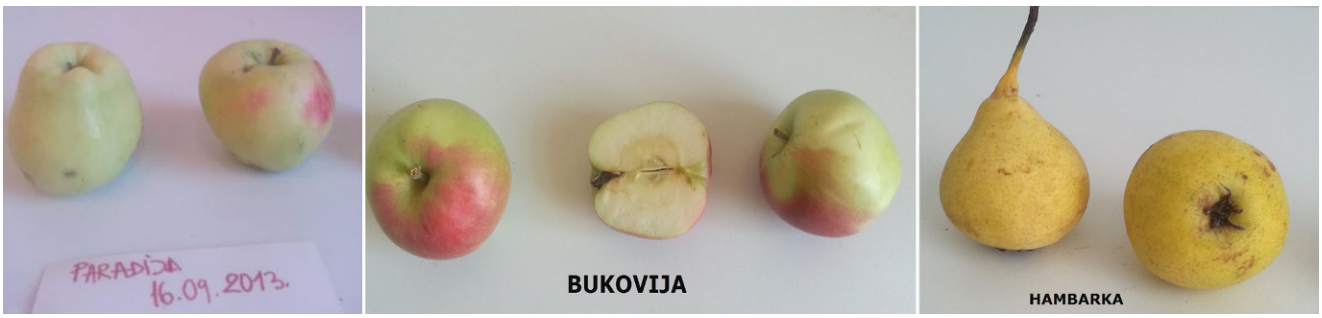


Fig. 4 Traditional B & H apple cultivars 'Paradija' and 'Bukovija' and pear cv. 'Hambarka' with good flavour, which ranked highly in the panel tasting

In the plot of pear cultivars (Fig. 3), cvs 'Takiša', 'Hambarka' (Fig. 4), 'Dolokrahan' and 'Kačmorka' distinguished by their pleasant flavour in both harvest years. Especially good floral and odour intensity showed 'Begarika', 'Jeribasma', 'Ahmetova' and 'Hambarka' in 2012.

In comparison with commercial apple cultivars, many autochthonous cultivars had a better flavour characteristic. It is interesting that cv. 'Golden Delicious' owns very nice sensory attributes when grown in B & H unlike cvs 'Idared', 'Granny Smith' and 'Gala' with a lesser characteristic apple flavour in comparison with some autochthonous apple cultivars from B & H. The pear varieties 'Williams' and 'Sweet Harrow' scored well when grown in B & H unlike cvs. 'Alexander Lukas' and 'Gellerts', which were characterised by a lower intensity of flavour attributes.

Conclusion

Autochthonous apple and pears cultivars could be a highly favoured fruit for manufacturing owing to their unique flavour characteristics. Fruit products such as juices, jam and distillates could provide a unique aroma profile by adding some amount of much flavoured autochthonous cultivars. An especially high intensity of sweet, fruity and floral aroma showed apple cultivars: 'Prijedorska Zelenika', 'Paradija', 'Ljepocvijetka', 'Bukovija', 'Srebrenička' and pear cultivars 'Dolokrahan', 'Hambarka', 'Takiša', 'Kačmorka'. Pears 'Jeribasma', 'Begarika', 'Ahmetova' are characterized by intensive floral aroma and could be used as flavouring for distillates and juices.

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Conflict of interest A. Alihodzic, F. Gasi, P. Drkenda, A. Akagic, A. Vranac, M. Meland, O. Music and N. Spaho declare that they have no competing interests.

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