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Reviewed paper

Organic and Conventional Apple Varieties Cultivated in Albania, a Comparison of Quality Characteristics based on variety, region of cultivation and influence of drying

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Abstract

The goal of this study was to evaluate the quality parameters of apples Red Delicious (RD) and Golden Delicious (GD) varieties, cultivated under organic and non-organic condition in region of Korca (south eastern part of Albania) and Dibra (north eastern part of Albania), as well the comparison of fresh and dried apples.

The quality parameters evaluated were: dry matter (DM), total soluble solids (TSS), total acidity (TA), total ash, vitamin C, colour values (L,a*,b*), water activity (a_w) and sensorial characteristics. Organic and non-organic apples, fresh and dried were subjected to solid–liquid methanol 60% extraction, which served for bioactive compound determination as: total polyphenols, flavonoids, anthocyanin, and antioxidant activity with ABTS test.*

Results of this study revealed that among apple varieties existed differences on quality parameters, in terms of variety, region of cultivation, organic and non-organic fruits, fresh or dried, pre-treated or not which were significant, especially for bioactive compounds. It was noted that organic cultivated apples had higher quality, especially those cultivated in Diber, both for fresh or dried apples. Furthermore, GD was more appropriate to be hot air dried (in temperature 60^{o}C, air velocity 1m/s), offering products with enhanced quality and sensorial characteristics. The pre-treatment speeded up the rate of drying and overall acceptability of products.

This study may serve to fruit growing sector and networks, farmers, researchers and fruit processors, which wants to expand apple organic production and products diversification in Albania.

Keywords: *apple, drying, organic, Golden Delicious, Red Delicious, quality*.

Introduction

Apples (*Malus domestica* Borkh.) have been known and cultivated since ancient times, and nowadays, more than ten thousand of apple cultivars exist. Organic apples are plant products, which are controlled at all stages of production and processing, from the first step to the consumer, treated without the use of inputs and methods that harm humans, the environment or the ecosystem (INSTAT, 2021). The Organic agriculture in Albania current legislation relies on the Law no. 106/2016 “On biologic production, labelling of biologic products and their control”, Decision Council of Ministers no. 336, date 6.6.2018; Minister Order, no.131, date 28.3.2018; Decision of Council of Ministers, No. 830, date 18. 12. 2019; Decision of Council of Ministers, no. 859, date 24.12.2019; Order of Minister of Agriculture and Rural Development No.228, date 8.6.2020; Decision of Council of Ministers, no. 1030, date 16.12.2020; specifically designed to develop and support organic agriculture in the country. There are 113 operators under the control of ‘Albinspekt bio.inspecta’ and 8 operators under the control of ‘Ecocert SA’ (Cakraj, 2021). Albania has the potential to successfully develop organic farming, organic production is export-oriented and only large retail shops as supermarkets are offering imported organic products. Nevertheless the sector needs structural and sustainable interventions, financial support to

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collecting points, fresh rooms, and refrigeration for the distribution and conservation of fresh produce, know-how on: bio-inputs, training, extension service, publications, marketing, consumer education and development of the communication strategy. Apple growing is a sector of great relevance, but the sector faces several impediments for further development, even there are available the agri-ecological conditions for fruit production are relatively good and labour forces, the area of cultivation for '*Red Delicious'* is approximately 1.9 ha and for '*Golden Delicious'* 3.4 ha (Spornberger et al., 2010).

Fruit quality is becoming an important theme in organic fruit cultivation, and an increasing demand by the market exist. *Golden* and *Red Delicious* are classified as sweet and slightly sweet-sour apple varieties (Bloksma et al., 2002). The quality and chemical composition of apples may change during storage and especially after processing in order to obtain apple beverages (juice, cider, vinegar, alcoholic beverages) or other food products (jam, sauce, dry or canned apples) (Vidovi´c et al., 2020), and the main compounds affected by processing are antioxidants, among other nutrients. To our knowledge no data exist for physico-chemical parameters, bioactive compounds and drying kinetic of apple varieties cultivated in Albania under organic conditions, even the drying effect on these parameters. It is why was undertaken this study, which may serve to fruit growing sector and networks, farmers, researchers and fruit processors, which wants to expand apple production and products diversification.

Material and Methods

Table 1: Study samples' code

Variety				*Red Delicious*	*Golden Delicious*
Korca	non-organic	fresh		RD-KF	GD-KF
		dried	no pre-treated	RD-KD	GD-KD
			pre-treated with citric acid	RD-KDC	GD-KDC
	organic	fresh		RDO-KF	GDO-KF
		dried	no pre-treated	RDO-KD	GDO-KD
			pre-treated with citric acid	RDO-KDC	GDO-KDC
Dibra	non-organic	fresh		RD-DF	GD-DF
		dried	no pre-treated	RD-DD	GD-DD
			pre-treated with citric acid	RD-DDC	GD-DDC
	organic	fresh		RDO-DF	GDO-DF
		dried	no pre-treated	RDO-DD	GDO-DD
			pre-treated with citric acid	RDO-DDC	GDO-DDC

The study was conducted during years 2020-2021. Sample code (Tab. 1) were set according to variety *Red Delicious* (RD) and *Golden Delicious* (GD), region Korca (K) south eastern part and Dibra (D) north eastern part of Albania, fresh (F) or dried (D), pre-treated (C) or not, cultivated under organic (O) and non-organic condition. Drying kinetic was studied for sliced apples with pre-treatment (citric acid) or not, in a temperature of 60ºC and air velocity 1m/s according to Hoxha & Kongoli (2016). Quality parameters evaluated for fresh and dried apple varieties were: dry matter (DM), total soluble solids (TSS), total acidity (TA), total ash, vitamin C, colour values (L*, a*, b*), water activity (a_w) and sensorial characteristics. Organic and non-organic apples, fresh and dried (pre-treated or not) were subjected to solid–liquid methanol 60% extraction, which served for bioactive compound determination as: total polyphenols, flavonoids, anthocyanin, and antioxidant activity with ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) test. The analysis were done according to Hoxha & Kongoli (2021). For sensorial characteristics a panel evaluated the apples on the basis of colour, flavour, sweetness, texture, taste and overall acceptability using a 9 points Hedonic scale as described by Wills et al., (1990). Parameters of apple fruit fresh and dried were assessed at least in triplicates and presented as Mean ± standard deviation (SD).

Results

The analytical data from the apple cultivars are presented in Figure 1. The dry matter content ranged 16.40-20.21 g/100g FW, where the minimum dry matter contents were found in GD-KF, whereas the greatest amounts were found in RDO-KF, drying concentrated it over 4-fold. Soluble solids content is a good indicator of sugar content of apples and presumably of sweetness and varied between 13-17°Brix, highest values were registered also in GDO-KF, and the ratio TSS/TA resulted 44.98-61.15. The average value of titratable acidity expressed as malic acid, the predominant organic acid in apple fruits was 0.28 g/100g FW, and the highest titratable acidity was found in RD-DF, after drying it increased over 3-fold (0.59-0.96 g/100 g FW). pH values varied 4.20-4.50, which after drying were decreased 3.20-3.90. Total ash content varied 0.88-0.95 g/100 g FW, and no differences were noted. Water activity from 0.95-0.97 for fresh sample were reduced 0.54-0.65 in dried samples, which is consider a safe range for microorganisms' activity. The ascorbic acid contents were average 30.81 mg/100 g FW, and after drying could be retained till 7% (2.20 mg/100 g FW), the RD-DF variety had the highest values and slight differences existed among organic and non-organic production.

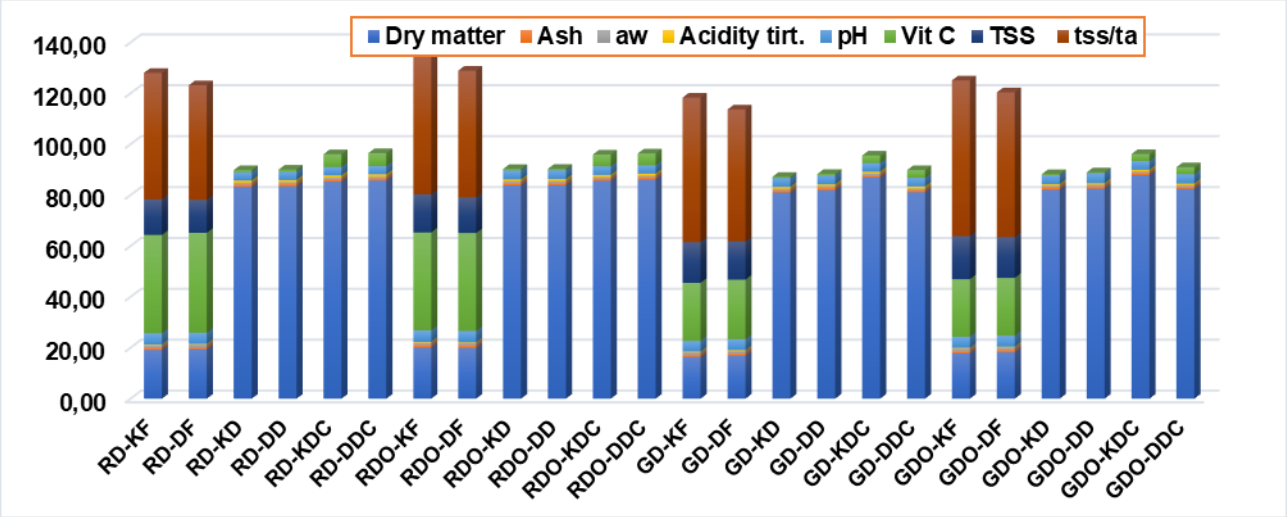

Figure 1: Fresh and dried apple varieties physico-chemical parameters: dry matter, TSS, ratio tss/ta, total ash, a_w, titratable acidity, pH and Vit C

Colour values L, a, b (Fig. 2) resulted respectively for fresh apples 25.22-7.22; 5.55-35.17; 18.54-15.27, for dried apples 22.38-6.85; 4.02-29.24; 18.11-11.74 and pre-treated 22.58-6.55; 4.02-25.71; 12.66-11.31 drying of apple significantly affect the colour of the apple tissue, and pre-treatment resulted in low browning effect. Colour is one of the most important aspects in determination of product quality, as it is directly related to consumers' appreciation of a product, it is directly linked to aroma and taste of the product and it tend to associate product colour and other visual properties with its taste, hygienic security, shelf life, nutritional value and personal satisfaction (Pedreschi, et al., 2006).

TPC values (Fig. 3) ranged for fresh non organic samples 81.59-106.96 fresh, dried 454.78-517.97, pre-treated 572.75-606.96; for organic 83.01-108.12 fresh, 519.11-467.13 dried, pre-treated 560.25-708.4 mg GAE/100 g FW. Differences among apples were seen depend on variety RD had 4% higher content compared to GD, depend on the region of cultivation where varieties grown in Dibra had about 3% higher content, depend on organic production with around 3% higher content. After drying a content till 5-fold happened, while

the pre-treatment contributed in 19% higher content compared to the same samples without treatment. The differences in levels of TPC suggests that RD, grown in Dibra, organic production apples are a better source of phenolic compounds than are GD.

TFC values (Fig. 3) ranged for fresh non organic samples 4.89-27.94 fresh, dried 32.11-35.72, pre-treated 40.17-45.72; for organic 6.12-29.14 fresh, 34.5-37.4 dried, and pre-treated 42.1-47.4 mg CE/100 g FW. Differences among apples were seen depend on variety GD had 31% higher content compared to RD, depend on the region of cultivation where varieties grown in Dibra had about 3% higher content, depend on organic production with around 19% higher content. After drying a content till 4-fold happened, while the pre-treatment contributed in 26% higher content compared to the same samples without treatment. The differences in levels of TFC suggests that GD, grown in Dibra, organic production apples are a better source of phenolic compounds than are GD.

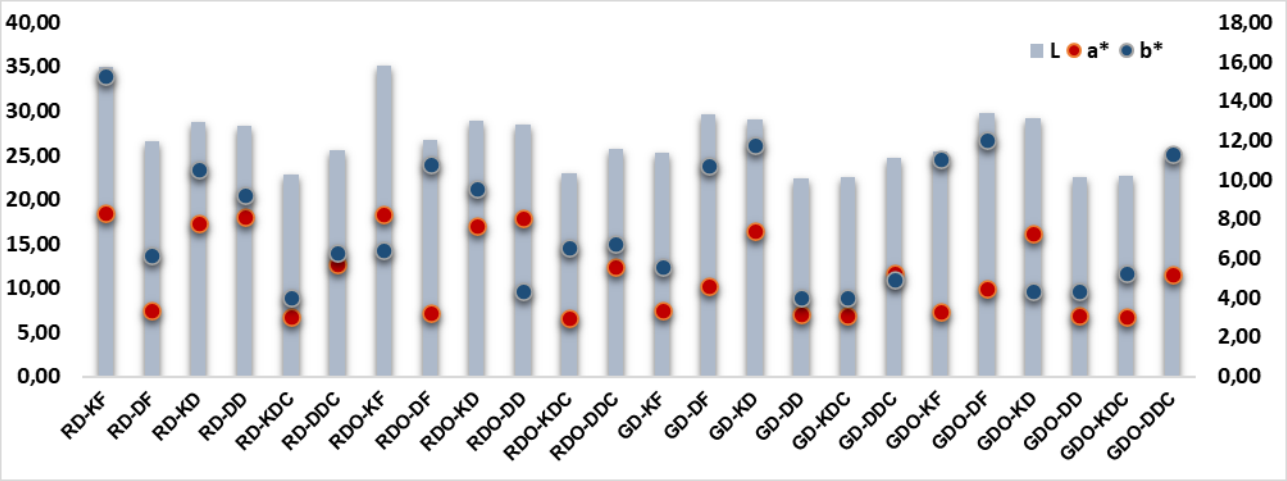

Figure 2: Fresh and dried apple RD and GD varieties colour values L*, a*, b*

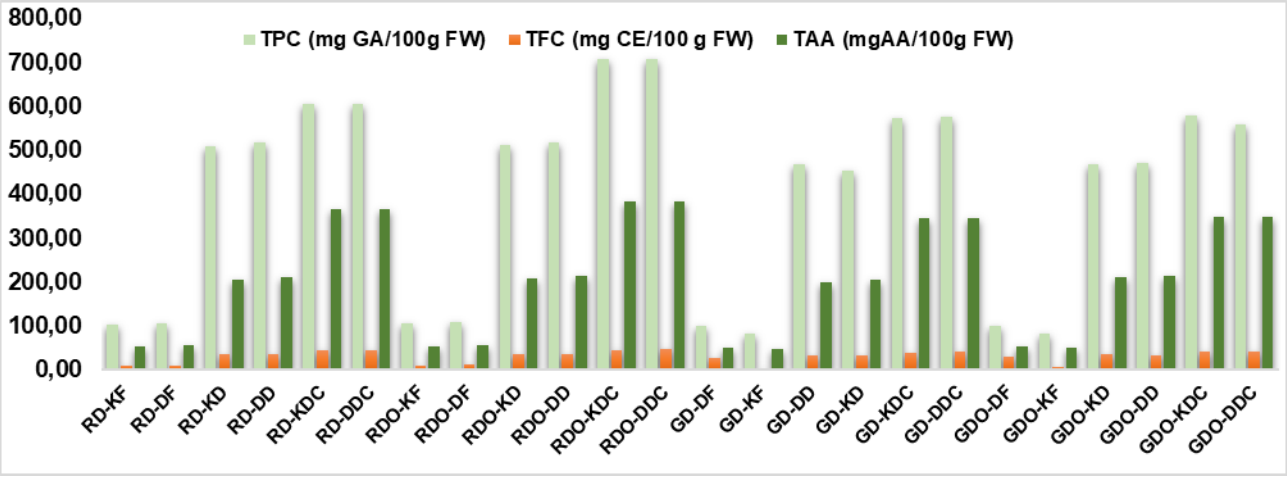

Figure 3: Total polyphenols, flavonoids and antioxidant activity in fresh and dried apple varieties

TAA values (Fig. 3) ranged for fresh non organic samples 48.65-56.04 fresh, dried 201.12-211.54, pre-treated 344.77-367.13; for organic 50.14-57.71 fresh, 208.38-214.51 dried, pre-treated 348.82-384.98 mg GAE/100 g FW. Differences among apples were seen depend on variety RD had 4% higher content compared to GD, depend on the region of

cultivation where varieties grown in Dibra had about 4% higher content, depend on organic production with around 3% higher content. After drying a content till 4-fold happened, while the pre-treatment contributed around 55% higher content compared to the same samples without treatment. The differences in levels of TAA suggests that RD, grown in Dibra, organic production apples are a better source of phenolic compounds than are GD. There are some studies regarding the overall antioxidant activity of apples and other fruits, indicating that TAA was well correlated with other antioxidant-related parameters such as total phenolic/flavonoid contents or the concentration of some specific antioxidant compounds, and similar studies on the overall antioxidant activity allow clustering of apple cultivars by location or processing technology (Bahukhandi et al., 2018; Fernández-Jalao, 2019). Consumers are becoming more interested in the content of the health-promoting compounds in fruit because of their antioxidant activity (Robards et al., 1999).

Sensorial characteristics are presented in Figure 4. Among apples had higher acceptability fresh GDO-DF (8.5), dried GDO-DD (7.86), GDO-DDC (8.06). Generally, GD variety resulted with highest scores for colour, texture, taste compared to RD variety, which resulted with highest score for flavour and sweetness.

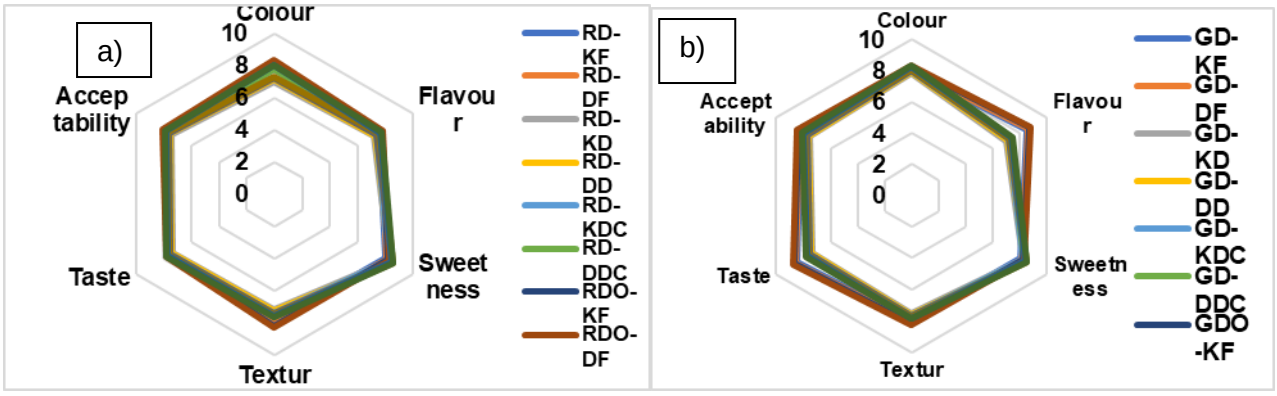

Figure 4: Apple varieties sensorial characteristics a) Red Delicious and b) Golden Delicious

The attractiveness of fruit to consumers is determined by visual attributes that include among others colour, as well as non-visual attributes such as taste, aroma, flavour, firmness (texture), where firmness and aroma appear to be the most important for consumers, where sugars, organic acids and phenolic compounds all contribute to the aroma of apples (Mikulič Petkovšek et al., 2009). Furthermore, GD was more appropriate to be hot air dried, offering products with enhanced quality and sensorial characteristics. Pre-treatment speeded up the rate of drying and overall acceptability of products.

Discussion

Physicochemical parameters and antioxidant activity of RD and GD apple varieties, grown in organic and non-organic conditions in Korca and Dibra regions in Albania were compared. From the comparison of evaluated quality parameters in this study expressed a higher quality organic GD variety cultivated in Diber, both for fresh or dried fruits. Drying concentrated dry matter over 4-fold, titratable acidity increased over 3-fold pH values were decreased 3.20-3.90, aw were reduced 0.54-0.65, which are consider safe range for microorganisms' activity, vitamin C content after drying could be retained till 7%. Colour values L, a, b resulted respectively for fresh apples 25.22-7.22; 5.55-35.17; 18.54-15.27, for dried apples 22.38-6.85; 4.02-29.24; 18.11-11.74 and pre-treated 22.58-6.55; 4.02-25.71; 12.66-11.31 drying of apple significantly affect the colour of the apple tissue, and

pre-treatment resulted in low browning effect. Among apples had higher acceptability fresh GDO-DF (8.5), dried GDO-DD (7.86), GDO-DDC (8.06). Generally, GD variety resulted with highest scores for colour, texture, taste compared to RD variety, which resulted with highest score for flavour and sweetness. The content of bioactive compounds depends strictly on the variety of apple, where RD resulted with highest TPC and TAA, whereas GD with highest TFC, also geographical location had a remarkable effect on the content of bioactive compounds of apple fruits, where those collected in Diber had higher values, as well organic production had the same effect. GD was more appropriate to be hot air dried, offering products with enhanced quality and sensorial characteristics. Pre-treatment speeded up the rate of drying and overall acceptability of products. Drying technology may be recommended by fruit processors as a chance for sustainable improvement of postharvest quality and storage of apple. These apple varieties can be a basic product for the manufacturing of many by-products with good nutritional values, and as a good source of natural antioxidants

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