APPLES AND DERIVATED BEVERAGES, BENEFITS FOR HEALTH

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Abstract

Apples and beverages are an important source of antioxidants, effective in fighting free radicals.
The apple has high nutritional value and can be eaten fresh as a fruit throughout the year or it can be a raw material for juice, nectar, puree, compotes, apple cider, vinegar and dehydrated fruit.
The objective of the paper is to present the nutritional and health benefits of apples and its derivatives from the scientific literature of food chemistry, horticulture, agriculture and medicine. Articles and online references have been consulted.
Knowing that apples and derived products are a source of polyphenols, the source of B and C vitamins, calcium, potassium phosphorus, and fiber, with antioxidant properties that reduce the risk of developing tumors, hypertension, diabetes, heart disease and brain aging .
The nutritional profile of the fruit, juice and apple cider are summarized as average values of polyphenols, antioxidant capacity and fiber, vitamins and minerals content.
Therefore, it is recommended to include the apple in the daily diet, both the core and the peel without neglecting the offer of juices, smoothies, cider and apple vinegar from Romania

Key words: (apple, apple juice, cider and vinegar, polyphenols, cancer prevention.

Apples and beverages are an important source of antioxidants, effective in fighting free radicals. The apple has high nutritional value and can be eaten fresh as a fruit throughout the year or it can be a raw material for juice, nectar, puree, marmalades, jams, compotes, apple cider, vinegar and dehydrated fruit.

Knowing that apples and derived products are a source of polyphenols, the source of B and C vitamins, calcium, potassium phosphorus, fiber and with antioxidant properties that reduce the risk of developing tumors, hypertension, diabetes, heart disease and brain aging. (Lichtenthaler R. and Marx F.- 2005).

Therefore, it is recommended to include the apple in the daily diet, both the core and the peel without neglecting the offer of juices, smoothies, cider and apple vinegar.

As apple is a strategic fruit in vegetable and fruit marketing, lots of researches have been done in relation to it.

The objective of the paper is to present the nutritional and health benefits of apples and its derivatives from the scientific literature of food chemistry, horticulture, agriculture and medicine. Articles and online references have been consulted.

MATERIAL AND METHOD

We analyzed over 80 scientific papers, books, reports and other on line resources in the field of food chemistry, agriculture and horticulture and medicine in order to concise a literature reviews.

RESULTS AND DISCUTIONS

The nutritional profile of the fruit, juice and apple cider, as average values of polyphenols, antioxidant capacity and fiber, vitamins and minerals content are summarized. About 65% are eaten fresh (about 60-70 apples, or more than 1 per week).

In Romania 65.1% of population eat not daily fruit and vegetable, around 30 % eat 1-4 portions and only around 3% consume >5 portions /day, comparative with average EU-28 shows in table nr.1.

A medium-sized apple contains about 80 calories, and is unusually high in fiber: generally about 5 grams per fruit (mostly from pectin).

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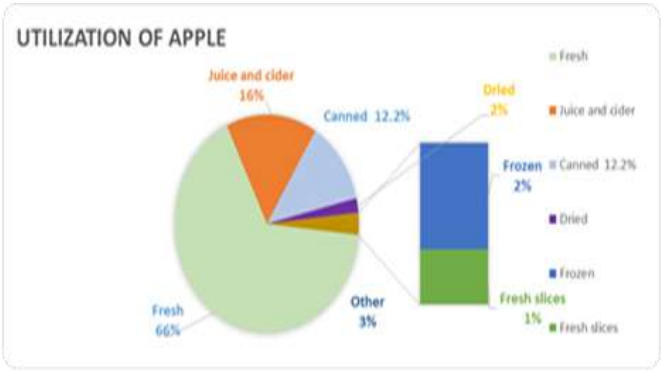

Figure 1 **.Utilization of apple**

Table 1.

Daily consumption of fruit and vegetables, 2014

	Not daily	Daily	
		From 1 to 4 portions	5 portions or more
EU – 28	34.4	51.4	14.1
Romania	65.1	31.4	3.5

Depending on the variety and apples cultivars (there are over 10,000 varieties grown), the main constituent element, 83-93% (http://nutritiesidietetica.ro /620/) is water, hence the low calorie content, a tennis ball size of less than 100 calories (an average pot of 180 g has 91.2 calories). These calories come mainly from carbohydrates, a medium sized marrow has 21.6 g of complex carbohydrates, other macronutrients are found in very small quantities, 0.72 g lipids and 0.54 g protein.

Fruit color is a characteristic for quality assessment and, at the same time, an indicator for appre-ciation of maturity for harvesting. Color is a characteristic of a species or variety and is determi-ned by the presence of pigments in epidermis and hypoderm cells (apples). Depending on the color changes that take place during the fruit growth and maturation process, we distinguish the following colors:

• Green background color, characteristic of the unmatched fruit, which is conferred by chlorophyll pigments. In mature fruits, the background color becomes yellow and is due to the biodegradation of chlorophyll pigments and carotenoid biosynthesis.

• Coating color is present on the sunny side of the fruit, but can almost completely cover the fruit surface (apple).

• Overlapping color appears in the form of strips, strips or spots of different shapes and sizes, being determined by the presence of anthocyanic pigments.

Epicarp color is a variety character. Thus, in the case of apples, there are varieties of a color (yellow to Golden Delicious and green to Granny Smith, Renet Simirenko) with two colors (ex. Winter Banana) or three colors (eg, Jonathan, Starking Delicious, etc.). (http://www.agroconect.md/infoview.)

The fibers – amount 4.3 g for a medium apple (25-35 g of fiber per day recommended) are found in the bark of the apple and its pulp, both the insoluble and the soluble, such as pectin, having beneficial roles for health as a delay in gastric emptying and a slowing rate of digestion and absorption of simple fat and sugar, lowering LDL-cholesterol ("bad cholesterol") and preventing constipation (Mariana Graur *et al.*, 2006).

Phenolic compounds are directly linked to the major organoleptic criteria of apples and their products (apple juice, cider, etc.).

The most important nutrients present in apple, apple juice, cider and vinegar are presented in table 2.

Phytochemicals present in apples, such as quercetin (7.3 mg in a medium apple) and catechin (2.3 mg in a medium apple) from the flavonoid family have a powerful antioxidant effect and having important role to prevent degenerative diseases like cancers (Ribeiro F.A. et.al., 2014) and cortical diseases such as cardiovascular ischemic disease, asthma and type 2 diabetes mellitus (Knekt P, et al., 2002).

In the apple peel there is a compound called ursolic acid that has been associated with stopping tumor cell proliferation and apoptosis (death) of cancer cells (Wang X, et al. 2011) reducing obesity, glucose tolerance and fatty liver with potential for therapeutic management of obesity and disease come with it (Kunkel S.D. et al. 2012) but all these effects have been demonstrated for the time being only in studies on laboratory mice.

Table 2.

Main nutrients in apple, juice, apple cider and vinegar

Nutrient	*Value*	*Reference*
APPLE		
Polyphenols		
Total polyphenol, (mg/kg) (English cider apple)	546-6306	(Marks SC., et al, 2007)
67 dessert apples (mg L−1)	1046-5448	(Wojdylo A, et al, 2008)
German cider Apples (mg L−1)	261.2–970	(Kahle K, et al, 2005)
Spanish cider Apples (mg L−1)	570–2060	(Mangas JJ, et al, 1999)
Dessert apples (mg L−1)	154.4–178	(Kahle K, et al, 2005)
Chlorogenic (µg/g)	25.6 – 136 1.5 - 228	(Coseteng and Lee, 1987) Lee and Wroletad, 1987
Epicatechin (µg/g)	30-23.4	Coseteng and Lee, 1987
Flavonoide (µg/g)	Trace - 28.8	Coseteng and Lee, 1987
pH	3.37-4.24	EiseleT.A., et al, 2005
Brix	10.26-21.62	Eisele T.A., et al, 2005
Antioxidant activity –napple peled (µmol Trolox equivalents)	640	G. Paganga et al (1999)
Carbohidrati, glucide		Caracteristi of PPO 626051
Sucroza (g/100 ml)	12.4 – 16.83	Radu IF, 1985
Fructoza (mg/100g)	0.422-14337	Cerbu E. – teza de doctorat
Sorbitol (g/100 g)	0.51	https://www.food-intolerance-network.com/food-intolerances/ sorbitol-intolerance-problem-dried-fruits/ sorbitol-contents-in-food.html
Carbohidrati, Fibre (g/100g)	2.03	http://www.apple-cider-vinegar-benefits.com/apple-cider-vinegar-health-benefits.html
Acid malic (g/L)	0.14 – 0.42; 10.12	Caracteristi of PPO 626051; *Del Campo et. al.,*2006
Acid ascorbic (g/L)	1.15 – 3.16	Rap. in Rev. de Pol. St. si Sc. – Nr.Sp. 2005 – ISSN-1582-1218
Acid citric, (g/L)	0.36	*Del Campo et. al.,*2006
Umiditate (%)	83.2-88.4	http://www.foodcomp.dk/
Minerals		
Sodiu, (mg)	2 – 3	http://www.foodcomp.dk/
Potasiu, (mg)	77 – 343	http://www.foodcomp.dk/
Calciu, (mg)	3.08 – 4.74	http://www.foodcomp.dk/
Magneziu, (mg)	3.3 – 5.66	http://www.foodcomp.dk/
Fosfor, (mg)	8.9 – 25.1	http://www.foodcomp.dk/
Fier, (mg)	0.124	http://www.foodcomp.dk/
Vitamin A (% RDA) Beta caroten eq. (µg)	1.8 2.08 18-32	http://www.fruit-crops.com/apple-malus-domestica/ http://www.foodcomp.dk/ http://www.foodcomp.dk/
Vitamin E alpha-tocopherol (mg)	0.43-0.66	http://www.foodcomp.dk/
Vitamin K(µg)	3	http://www.foodcomp.dk/
Thiamin, B1	2.1 0.011-0.025	http://www.fruit-crops.com/apple-malus-domestica/ http://www.foodcomp.dk
Riboflavin, B2	1.2	http://www.fruit-crops.com/apple-malus-domestica/
Niacin	0.6	http://www.fruit-crops.com/apple-malus-domestica/
Vitamin C	16	http://www.fruit-crops.com/apple-malus-domestica/
Calcium	0.9	http://www.fruit-crops.com/apple-malus-domestica/
Phosphorus	1.2	http://www.fruit-crops.com/apple-malus-domestica/
APPLE JUICE		
Polifenoli (mg/l)	740 – 3742 1058-6414	Koseva M. R.*et al*, 2016 (Verdu C, *et al*, 2013)
Chlorogenic (µg/ml) (ppm)	8.8 – 113.7 1.5-396.9	Spanos et al., 1992 Eisele T.A*., et al*, 2005
Caffeic, µg/ml (ppm)	1.9 – 9.6 ND-31.8	Coseteng and Lee, 1987 Eisele T.A*., et al*, 2005
Coumaric (µg/ml) (ppm)	1.5 – 6.2 ND-19.4	Spanos et al., 1992 Eisele T.A*., et al*, 2005
Epicatechin, (µg/ml) (ppm)	3.5 – 44.4 ND-148.5	Spanos et al., 1992 Eisele T.A*., et al*, 2005
Catechin, (ppm)	ND-52	Eisele T.A*., et al*, 2005
Flavonoide, (µg/ml)	6.3 – 51.8	Spanos et al., 1992
Phloridzin, (ppm)	0.9-120.3	Eisele T.A*., et al*, 2005
Ferulic, (ppm)	ND-2.4	Eisele T.A*., et al*, 2005
Rutin, (ppm)	ND-45.5	Eisele T.A*., et al*, 2005
pH	3.37-4.24	Eisele T.A*., et al*, 2005
Brix °	10.26-21.62	Eisele T.A*., et al*, 2005
Carbohidrate, glucide (%)	10.2	http://www.foodcomp.dk/
Sucrosse (mg/100g) (%)	0.38-5.65 0-4.28	Eisele T.A*., et al*, 2005 Cerbu E. – PhD thesis
Glucose (mg/100 g) (%)	1.05-3.23 0.29-4.06	Eisele T.A*., et al*, 2005 Cerbu E. – PhD thesis
Fructose (mg/100g)	3.84-8.01	Eisele T.A*., et al*, 2005

(%)	0.422-14.33	Cerbu E. – PhD thesis
Sorbitol (%) (g/100 g) (g/L)	0.17-1.4 0-4.28 0.56 3-8 g/L	Eisele T.A*., et al*, 2005 Cerbu E. – teza de doctorat https://www.food-intolerance-network.com/food-intolerances/sorbitol-intolerance-proble-dried-fruits/sorbitol-contents-in-food.html Koseva M. R.*et al*, 2016
Fru/Glu Ratio	1.3-6.73	Eisele T.A*., et al*, 2005
Acid malic (mg/100 ml)	193.3-1738.2	Eisele T.A*., et al*, 2005
Acid citric (mg/100 ml)	0.8-27.4	Eisele T.A*., et al*, 2005
Acid Shikimic (mg/100 ml)	0.3-4.6	Eisele T.A*., et al*, 2005
Acid Fumaric (mg/100 ml)	ND-0.89	Eisele T.A*., et al*, 2005
Moisture (%)	87.9	http://www.foodcomp.dk/
Minerals		
Sodium, (mg) (ppm)	5.4 – 17.1 0.5-73.4	http://www.foodcomp.dk/ Eisele T.A*., et al*, 2005
Potassium, (mg) (ppm)	76 – 83 765,9-2712.3	http://www.foodcomp.dk/ Eisele T.A*., et al*, 2005
Calcium, mg (ppm)	8.3 – 11 18.7-80.3	http://www.foodcomp.dk/ Eisele T.A*., et al*, 2005
Magnezium, (mg) (ppm)	4.3 – 4.9 35.2-100.5	http://www.foodcomp.dk/ Eisele T.A*., et al*, 2005
Phosphor,(mg) Phosphate (ppm)	5.6 – 6.4 86-459	http://www.foodcomp.dk/ Eisele T.A*., et al*, 2005
Iron ,(mg)	0.250 – 0.290	http://www.foodcomp.dk/; Eisele T.A*., et al*, 2005
Cupru, (mg)	0.04 – 0.07	http://www.foodcomp.dk/
Zinc,(mg)	0.028 – 0.049	http://www.foodcomp.dk/
Iod, (µg)	0.25 – 0.9	http://www.foodcomp.dk/
Mangan, (mg)	0.45 – 0.68	http://www.foodcomp.dk/
Vitamin A (% RDA) Beta caroten eq. µg	1.8 18-32	http://www.fruit-crops.com/apple-malus-domestica/ http://www.foodcomp.dk/
Vitamin E alpha-tocopherol (mg)	0.43-0.66	http://www.foodcomp.dk/
Vitamin K(µg)	3	http://www.foodcomp.dk
Thiamin, B1	2.1 0.011-0.025	http://www.fruit-crops.com/apple-malus-domestica/ http://www.foodcomp.dk/
Riboflavin, B2	0.017	http://www.fruit-crops.com/apple-malus-domestica/
Niacin (eq)	0.117	http://www.fruit-crops.com/apple-malus-domestica/
Vitamin C (mg)	0.9	http://www.fruit-crops.com/apple-malus-domestica/
Folates ,(µg)	0.13	http://www.fruit-crops.com/apple-malus-domestica/
Phosphorus	1.2	http://www.fruit-crops.com/apple-malus-domestica/
Vitamin A (% RDA) Beta caroten eq. (µg)	1.8 2.08 18-32	http://www.fruit-crops.com/apple-malus-domestica/ http://www.foodcomp.dk/ http://www.foodcomp.dk/
Vitamin E alpha-tocopherol (mg)	0.43-0.66	http://www.foodcomp.dk/
Vitamin K(µg)	3	http://www.foodcomp.dk/
APPLE CIDER		
Polyphenols (Wild –Safale)	219-321.7 188.4-2778.17	Koseva M. R.*et al*, 2016 Nogueira A. *et a*l,2008
Chlorogenic	143 - 903	Nogueira A. *et a*l,2008
Caffeic	0 – 41.8	Nogueira A. *et a*l,2008
Epicatechin	0 – 146.9	Nogueira A. *et a*l, 2008
Flavonoide	0 - 1711	Nogueira A. *et a*l, 2008
Folin Ciocalteu Index (Acid Tannic/L)	1.37-0.8;0-140 days	(wileyonlinelibrary.com) DOI 10.1002/jsfa.7036
TPI (A280 nm)	31-18.4; 0-140 days	(wileyonlinelibrary.com) DOI 10.1002/jsfa.7036
Hidroxicinamics (A 320 nm)	24- 8.6; 0-140 days	(wileyonlinelibrary.com) DOI 10.1002/jsfa.7036
FRAP (mmol Trolox L−1)	2.8- 4.1; 0-140 days	(wileyonlinelibrary.com) DOI 10.1002/jsfa.7036
Antioxidant activity (µmol Trolox)	100-2595	G. Paganga *et al* (1999)
Acid ascorbic(vitamina C)(mg/100 g)	1.5	http://nutritiondata.self.com/facts-C00001
Acid malic, (mg/100 g)	1.29-2.26	Miles C, 2013
Taninuri, (%)	0.68 – 0.19	Miles C, 2103
Alcool (%)	4.5 – 8.2; 0.05-13.1 5-20	Marks SC., *et al*, 2007 Koseva M. R.*et al*, 2016
Metanol (mg/L)	<120	Koseva M. R.*et al*, 2016
Sugars (°Brix)	10-20 7.2–7.8 Brix	Koseva M. R.*et al*, 2016
Sorbitol (g/L)	4-6 g/L	Picinelli, A, et al., 2000
Acizi nevolatili (%)	0.4-0.6	Koseva M. R.*et al*, 2016
Minerals		
Sodiu, (mg/L)	25 18-61 31	http://nutritiondata.self.com/facts-C00001- Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995 Rupasinghe, HP.V. and Clegg, S., 2007
Potassium, (mg/l) (mg/100 g)	1654 ; 1044-1900; 58.3 958	http://nutritiondata.self.com/facts-C00001 Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995 http://nutritiondata.self.com/facts-C00001l Rupasinghe, H.P.V. and Clegg, S., 2007
Calciu, (mg/L)	11-17	Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995
Magneziu, (mg/L)	97-144	Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995

	38	Rupasinghe, H.P.V. and Clegg, S., 2007
Fier, (mg/100 g) (mg/L)	1.2 0.19-0.32 0.4	http://nutritiondata.self.com Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995 Rupasinghe, H.P.V. and Clegg, S., 2007
Cupru, (mg/L)	3.03-4.31	Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995
Zinc, (mg/L)	0.82-1.01 0.2	Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995 Rupasinghe, H.P.V. and Clegg, S., 2007
Mangan, (mg/L)	0.76-1.54 0.2	Bhutani, V.P. *et al.,* 1989; Bhutani, V.P. *et al.,* 1995 Rupasinghe, H.P.V. and Clegg, S., 2007

Vitamins that we find in large amounts in apple are vitamin C (8.3 mg in a medium grain), β-carotene (49 μg), choline (6.2 mg) and folate (5 mg).

Among the best-represented minerals is 195 mg potassium in an average marrow followed by 11 mg of calcium and 9 mg of magnesium.

Most apple nutrients are found in the bark and immediately below it, so it is recommended to consume them without cleaning them. (Forwood S. E. *et al*., 2013).

The aroma of apples is given by amyl esters, caprionic, formic and acetic acids, geraniol and acetic aldehyde, and the taste by is succinic, gallic and malic acids - all of which make the apple a versatile food that can satisfy a wide range of tastes preferences (Ringhi-lescu I. available on-line at http://nutritie-sidietetica.ro/620/). Procyanidins are directly responsible for the astringent sensation resulting from their complexation with salivary proteins. They are also involved in the bitter taste of cider as the result of specific interactions with bitterness receptors in the mouth. The intensity of these sensory properties is directly linked to the procyanidin structures and, in particular, their degree of polymerisation.

Chlorogenic acid is the preferential substrate of the polyphenol oxidase. In the presence of oxygen, it is enzymatically converted into *O*-quinone, which further reacts with catechins, procyanidins and hydrochalcones, resulting in the formation of oxidation products including yellow–orange molecules responsible for the colour of apple juice and cider (Verdu C F,*et al*, 2013), (Oszmianski J and Lee CY,1990), (Song Y, et al., 2007).

An increase in the activity of the enzymes, as well as in the level of phenolic compounds, could combine with the temperature-dependent phase changes in the cellular membrane, to affect the shelf life of stored fruit and vegetables by providing an adequate substrate to the browning reactions. In vivo, the phenolic substrates of PPOs are localised in the vacuole and browning only occurs as a result of tissue damage leading to a loss of this sub-cellular comparti-mentalisation (Guyot S., et al., 2008)

As reviewed by Hyson, there are reports that apple consumption may lead to reduced risks of chronic diseases such as cancer, cardiovascular disease, asthma and Alzheimer's disease. Moreover, apples have been reported to have a positive effect on cognitive decline, diabetes, weight management, bone health, pulmonary function and gastrointestinal protection (Hyson D.A, 2011)

Cider apple varieties contain relatively large amounts of polyphenolic compounds, which can be divided into fourclasses: hydroxycinnamic acid derivatives, flavan-3-ols, either monomeric (catechins) or oligomeric (procyanidins), flavonols and dihydrochalcones Polyphenolic compounds, particularly procyanidins, are responsible for haze and sediment formation because of their interaction with proteins (Zuriarrain A, et al., 2014), (Siebert K.J. 2006). and (Guyot S. et al., 1998).

Quercetin, a member of the bioflavonoids family, has been proposed to have antiatherogenic, anti-inflammatory, and anti-hypertensive properties leading to the beneficial effects against cardiovascular diseases (Keisuke I. et al., 2011).

CONCLUSION

In the course of a calendar year, starting in July when fresh apple appear on the early stages and until the end of November, the diversity of apples in Romania ensures the direct selling and distribution from the producers on the Romanian markets.

The rich nutrient content of both apples and fresh juices obtained or traded in stores raises this period until march and at the beginning of spring when the place of the fresh can be replaced with apple cider, - suitable for consumption with the increase in temperatures, and vinegar apples used as dressing salads.

Therefore, it is recommended to include the apple in the daily diet, both the core and the peel without neglecting the offer of juices, smoothies, cider and apple vinegar from Romania.

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The present review is part of the first author PhD literature study in the field of apple cider.

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