Studii şi Cercetări	Martie 2019	Biologie	28/1	159-166	Universitatea"Vasile Alecsandri" din Bacău

THE POTENTIAL OF *CUCURBITACEAE* VEGETABLES TO BE USED AS MEDICINAL, FOOD AND DECORATIVE

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Key words: *genetic resources, purposes, nutritional, yield*

INTRODUCTION

The *Cucurbitaceae* is a remarkable plant family, deserving of attention because of its economic, aesthetic, cultural, medicinal, and botanical significance. In the Old and New Worlds, cucurbits have been associated with human nutrition and culture for more than 12,000 years (Brothwell and Brothwell 1969; Lira-Saade 1995). *Cucurbitaceae*, along with *Brassicaceae* and *Asteraceae*, can be considered families of extraordinary importance to humans, and they follow cereals and legumes in their economic significance to human economy (Whitaker and Davis 1962; Nayar and More 1998).

The family *Cucurbitaceae* includes a large group of plants which are medicinally valuable. It is a family of about 130 genera and about 800 species. Fruits of *Cucurbitaceae* have a considerable economic value. One of the main uses of the cucurbits apart from their fruits, leaves, flowers and occasionally their root is that of its seeds.

The seed kernels of the *Cucurbitaceae* family found in markets throughout West Africa are an important source of oil used for food. Those oil-rich seeds are found in a range of genera of which the most important are *Citrullus* (watermelon), *Cucurbita* (pumpkin), *Lagenaria* (bottle gourd), *Cucumis* (melon) and *Luffa* (sponge gourd) respectively. Seeds or fruit parts of some cucurbits are reported to possess purgatives, emetics and antihelmintics properties due to the secondary metabolite cucurbitacin content.

Several compounds of this group have been investigated for their cytotoxic, hepatoprotective, anti-inflammatory and cardiovascular effects. Cucurbitacins constitute a group of diverse triterpenoid substances which are well known for their bitterness and toxicity.

They are highly oxygenated, tetracyclic triterpenes containing a cucurbitane skeleton characterized. The cucurbitacins are arbitrarily divided into twelve categories, incorporating cucurbitacins A-T. A lot of work has been done by the researchers throughout the world on various plants of the family *Cucurbitaceae*. Some of the important plants that have been extensively studied are *Momordica charantia*, *Cucurbita pepo*, *Cucurbita maxima*, *Cucumis sativus*, *Cucumis melo*, *Citrullus lanatus*, *Luffa acutangula, Luffa cylindrical, Lagenaria siceraria* etc.

MATERIAL AND METHODS

The biological material of this study was represented by species of *Cucurbitaceae* family, as they are listed in Table 1.

The study was conducted as a review of multiple uses of investigated species, in order to highlight medicinal benefits. The selection of investigated species was realized based on their importance in our area, and their potential use as medicinal related to their chemical content.

The focus species were: *Momordica charantia, Cucurbita pepo, Cucurbita maxima, Cucumis sativus, Cucumis melo, Citrullus lanatus, Luffa acutangula, Luffa cylindrica, Lagenaria siceraria.*

RESULTS AND DISCUSSIONS

Cucurbits are a family of healthy foods. Cucumbers are a prime dieting food. They are 96 percent water, with a little fiber and only a few calories. In addition, it provides a good source of vitamins A, K, and C, as well as a large amount of potassium. The National Cancer Institute has identified certain properties of the cucumber as having cancer preventative benefits. Cucurbits *(Cucurbitaceae)* are among the most important plant families supplying humans with edible products and useful fibers. Cucumbers are consumed either raw or pickled. Pickling is a common way to preserve the cucumber for longer periods of time. Historically, it allowed them to be available long after the normal growing season.

Cucurbitacins constitute a group of diverse triterpenoid substances which are well known for their bitterness and toxicity. They are highly oxygenated, tetracyclic triterpenes containing a cucurbitane skeleton characterized as 19-(10→9β)-abeo-10α-lanost-5-ene (also known as 9β-methyl-19-

nor lanosta-5-ene) (Pryzek, 1979). The cucurbitacins are arbitrarily divided into 12 categories, incorporating cucurbitacins A-T. The various cucurbitacins differ with respect to oxygen functionalities at various positions. The structures of a few cucurbitacins (A, C, B and D). These cucurbitacins are also present in their glycosidic forms such as cucurbitacin B glucoside containing glucose as the glycone moiety.

Cucurbits have inspired the creation of an incredible number of cultivars: *Momordica charantia,*

Cucurbita pepo, Cucurbita maxima, Cucumis sativus, Cucumis melo, Citrullus lanatus, Luffa acutangula, Luffa cylindrica, Lagenaria siceraria mentioned also the cultivated *Cucurbitaceae* species for medicinal use listed in Tabel 1. The most important of them in terms of frequency in wild flora and use in traditional folk medicine are: *Bryonia alba* L., *Echinocystis lobata* (Michx.) Torr. et A. Gray and *Ecballium elaterium* (L.) A. Rich. as listed in Table 2, together to their main pharmacological effects, according to literature. Related to the plant organ, the following symbols were used in the table: Fl– flowers, Fr – fruit, Le – leaves, U – underground organs, Pl – plant, Se – seeds.

Table 1 List of spontaneous and cultivated *Cucurbitaceae* medicinal plants

No	Spontaneous (S)/Cultivated (C)	Org	Traditional use
1	*Bryonia alba* (L.) (S)	U	-for antipyretic, diaphoretic, anti-inflammatory, anti-infectious, anti-rheumatic, analgesic, laxative, purgative, relaxing smooth muscle properties;
2	*Citrullus lanatus* (Thunb.) Matsum. & Nakai (C)	Fr, Se	-as purgative and emetic in high dose, vermifuge, demulcent, diuretic and tonic, - urinary tract infections, bed wetting, dropsy and renal stones, alcohol poisoning, hypertension, diabetic, diarrhea and gonorrhea;
3	*Cucumis melo* (L.) (C)	Fr	-chronic eczema, tonic, laxative, galactagogue, diuretic and diaphoretic, anti-inflammatory properties;
4	*Cucumis sativus* (L.) (C)	Fr	-constipation and aid indigestion, tonic, diuretic and anthelmintic, demulcent, antiulcer;
5	*Cucurbita maxima* (L.) (C)	Fr, Se	-anticancer, anti-inflammatory, diuretic, tonic;
6	*Cucurbita pepo* L. (C)	Fr	-increases appetite, cures leprosy and purifies the blood, cure sore chests, hemoptysis, bronchitis and fever, benign prostatic hyperplasia, antioxidant;
7	*Ecballium elaterium* (L.) A. Rich. (S)	Fr	-for anti-inflammatory, anti-bacterial, analgesic, laxative, purgative, trypsin inhibitor and cytotoxic activities;
8	*Echinocystis lobata* (Michx.) Torr. et A. Gray (S)	U	-for headaches, for the analgesic effect or as a tonic drink for stomach pain, kidney diseases, rheumatism, chills and fever;
9	*Lagenaria siceraria* (Molina) Standl. (C)	Le, Fl, Fr, Se	-emetic and purgative, headaches, antidote to poison, diuretic, stomach acidity, indigestion and ulcers, treatment of boils, aching teeth and gums, boils, diabetes mellitus;
10	*Luffa acutangula* (L.) Roxb. (C)	Fr, Se, Le, Fl	-emetic and purgative, expel intestinal worms, venereal diseases, particularly gonorrhea, eczema, conjunctivitis, antitumor;
11	*Luffa cylindrica* (L.) M. Roem. (C)	Fr, Se, Le, Fl	-prevent any eye ailments, provide you with cardiovascular benefits, prevent diabetes, muscle pain, reduce the symptoms of arthritis, treat anemia, excellent skin health, migraines and headaches, improve the brain function;
12	*Momordica charantia* (L.) (C)	Fr, Le	-anthelmintic, antiemetic, carminative, purgative and for the treatment of anemia, jaundice, malaria, cholera, diabetes, antihyperglycemic, antioxidant;

Table 2 Pharmacological effects of the most popular spontaneous *Cucurbitaceae* species in investigated area

Species	The main pharmacological effects	Reference
Bryonia alba (L.)	-antipyretic effects, -anti-inflammatory, anti-infectious, -anti-rheumatic, analgesic effects, -laxative, purgative effects, -relaxing smooth muscle properties;	-Lavinia Rus, 2015 -Irina-Ioana Ielciu, 2015 -Ramona Păltinean, 2015 -Laurian Vlase, 2015 -Cristina Ştefănescu, 2015 -Gianina Crişan, 2015
Ecballium elaterium (L.) A. Rich.	-anti-inflammatory, -anti-bacterial, analgesic, -laxative, purgative effects, -trypsin inhibitor, -cytotoxic activities;	-Irina-Ioana Ielciu, 2016 -Michel Frederich, 2016 -Monique Tits, 2016 -Luc Angenot, 2016 -Ramona Paltinean, 2016 -Ewa Cieckiewicz, 2016 -Gianina Crisan, 2016 -Laurian Vlase, 2016
Echinocystis lobata (Michx.) Torr. et A. Gray	-for headaches, -analgesic effect, -tonic drink for stomach pain, -kidney diseases, rheumatism, -for chills and fever;	-Shakhnoza S. Azimova, 2012 -Anna I. Glushenkova, 2012

Citrullus lanatus is a very refreshing fruit the best forms have a delicate sweetness with an extremely high-water content. The fruit is often used as a refreshing drink. The unripe fruits are added to soups. A syrup can also be made from the juice. The fruit is a rich source of pectin and can be added to pectin-low fruits when making jam. Pectin protects the body against radiation. The fruit varies considerably in size from cultivar to cultivar but can be up to 1 meter long and 40cm wide. A nutritional analysis is available. An edible oil is obtained from the seed. Highly prized, it is used for cooking. The roasted seed can be used as a coffee substitute. Chemical composition: higher value ($p< 0.05$) of *Citrullus lanatus* content was observed in pulp; it was 33.20% and agreed with finding by Mustafa et al. (1972). Where crude fiber of hull was high amount ($p<0.05$), it was 73.47 and lowest amount found in pulp is agreed with Al-Khalifa (1996). He is ranged between 2.5-6.14% but in hull is similar to finding by Hayat (1994). Whereas EE content of pulp was highest significant ($p<0.05$) when compared with other samples, it was 45.38 and lowest value founded by hull is similar to result obtained by Hayat (1994). Ash content of whole watermelon seed in this study is in line with range of 1.85-5.2% (Hayat, 1994; Mustafa et al., 1972). The chemical composition of watermelon seed was varied with other studies in many areas. This variation may be due to many factors concluded in climate, soil, variety, variation in seeds component, cultivation method, harvesting time, irrigation, growing condition and amount rain fall during the growing season. The ash content of pulp had been lowest amount, it was 1.43 closed followed by cake. Watermelon is very low in cholesterol and sodium. It is a very good source of magnesium and a good source of phosphorus, manganese and zinc. Next to tomato, watermelon is a rich source of lycopene, a powerful antioxidant. One hundred grams of watermelon flesh contain 91.5 g water, 7.2 g carbohydrates, 0.6 g protein, 0.5 g fiber, 0.2 g fat, 8.0 mg calcium, 0.2 mg iron, 11.0 mg magnesium, 9.0 mg phosphorus, 116.0 mg potassium, 2.0 mg sodium, 9.6 mg vitamin C, 0.14 mg vitamin B6, 366 IU vitamin A and 0.2 mg niacin. (figure 1, 2 and 3) The rind has high silicon content and is used to treat those suffering from diabetes and hypertension. Being diuretic, watermelon seeds stimulate functioning of kidneys and bladder. (Dhaliwal, 2017)

Cucumis melo are very watery fruits but with a delicate flavor, it is very refreshing. Rich in vitamins B and C. The flesh of the fruit can be dried, ground into a powder and used with cereals when making bread, biscuits etc. The size of the fruits and the yield varies widely between cultivars. (figure 4). Seed – raw are rich in oil with a nutty flavor but very fiddly to use because the seed is small and covered with a fibrous coat. An edible oil is obtained from the seed. Different studies reported the seed contains between 12.5 - 39.1% oil. The chemical composition of melon fruit has been analyzed in several types of melon and even in comparison with watermelon.

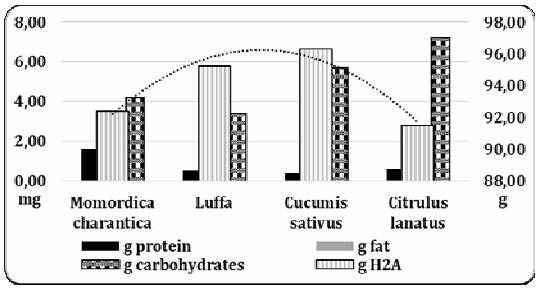

Fig. 1 Variation of protein, fat and carbohydrates content in several cucurbits

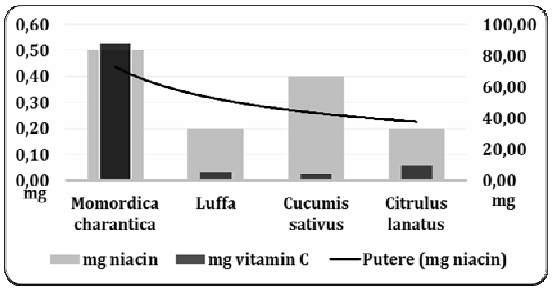

Fig. 2 Variation of protein content in several cucurbits

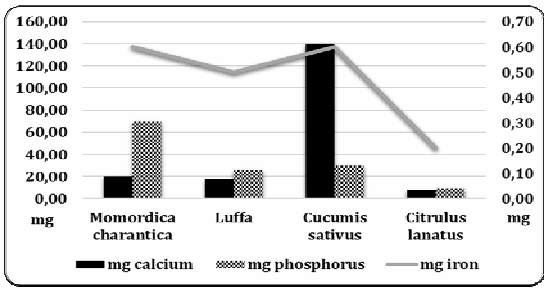

Fig. 3 Variation of mineral content in several cucurbits

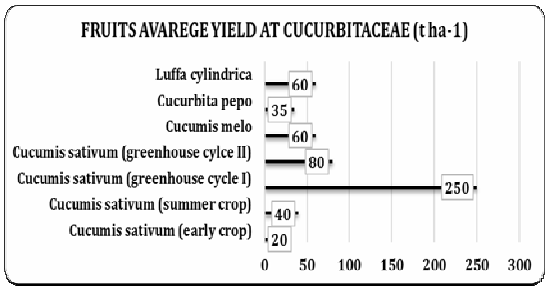

Fig. 4 Fruits average yield at several *Cucurbitaceae* species

With regard to the percentage of edible part the green melon differs from all types of melon analyzed. This in the case of melons the percentage of edible part is 45%, in watermelon the part consumed is 5% higher. The content in water varies from the species *Cucumis melo* between 87% at Honeydew and 92% in Csaba. Compared with the watermelon, no major differences were detected, with the water content of 90% (figure 5). The protein content of melon fruits ranges from 0.6% to Csaba melons and 1.0% at Cantaloup. Lipids were present in a percentage of 0.1% in all fruit analyzed by both melon and watermelon. The sweetest melons studied by Phrarr were Honeydew melons with a carbohydrate content of 10.1%, superior to melon melons that accounted for 7.0% carbohydrates and Csaba with 6.2% carbohydrates (figure 6). Green watermelons had 9.0% carbohydrates. Vitamins have been identified with thiamine, riboflavin, niacin and ascorbic acid.

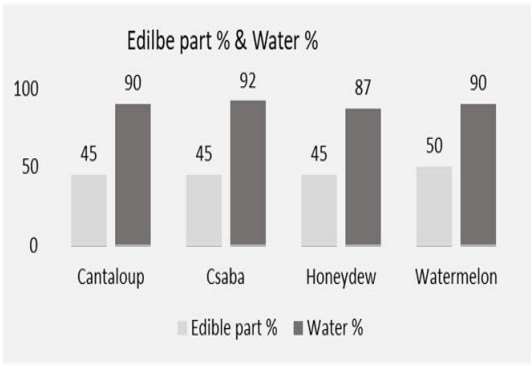

Fig. 5 Variation of water content and edible part in melon and watermelon

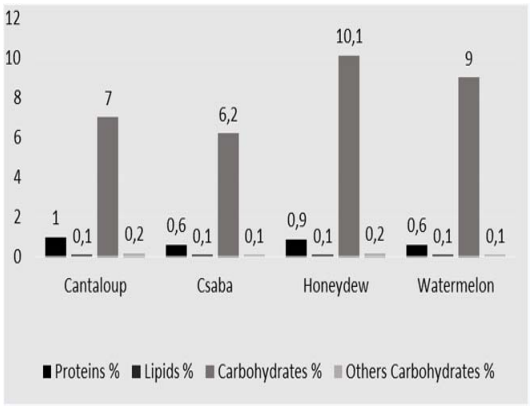

Fig. 6 Variation of protein lipid and carbohydrates content of melon and watermelon

Cucumis sativus is a common ingredient of salads, being valued mainly for its crisp texture and juiciness. However, it is very watery, with little flavor and is not very nutritious. Many people find the fruit to be indigestible, this is due to the high cellulose content. The fruit varies widely in size and shape between the various cultivars. It can be nearly globular to oblong and elongated, depending on the cultivar, with the larger fruits being up to 1-meter long oil from seed. Said to resemble olive oil, it is used in salad dressings and French cooking. The oil contains 22.3% linoleic acid, 58.5% oleic acid, 6.8% palmitic acid and 3.7% stearic acid. Cucumbers are common ingredients in facial creams, masks, cleansers etc. Sliced cucumber applied on the skin helps to soothe skin irritation and swelling. Cucumber juice is often recommended as a source of silicon to improve complexion and health of the skin. Cucumbers taste great and are fat-free, cholesterol-free and sodium-free. One hundred grams of fruit contain 96.3 g moisture, 0.4 g protein, 0.3 g minerals (140 mg calcium, 30 mg phosphorus, 0.6 mg iron), 0.4 g fibre, 5.7 g carbohydrates, 0.04 mg riboflavin, 0.4 mg niacin and 4.0 mg vitamin C. (Dhaliwal, 2107) (figure 1, 2 and 3)

Cucurbita maxima is a delicious flavor when baked, rather like a sweet potato. The flesh can be dried, ground into a powder and used with cereals in making bread, cakes, etc. Some varieties can be stored for up to 9 months. The fruits are normally large, weighing 4-5 kilos each, with some forms weighing 40 kilos or more. They vary considerably in shape, being round or oblong, covered with small raised spots, and the rind soft or hard. Seed - raw or cooked. Rich in oil with a very pleasant nutty flavor but very fiddly to use because the seed is small and covered with a fibrous coat. The seed can also be ground into a powder and used with cereals in making breads etc. An oil is obtained from the seed. Young flowers - raw or cooked. They are often dipped in batter and fried. Young leaves and stems - cooked. The leaves contain up to 5% protein. Seeds of a Tunisian variety (Béjaoui) of pumpkin (*Cucurbita maxima*) were analyzed for their main chemical composition and for their oil properties. Expressed on dry weight basis, seed moisture was 8.46%, whereas contents of proteins, fibre, ash, fat, and total sugars established at 33.92%, 3.97%, 21.97%, 31.57%, and 0.11% respectively. Gas chromatography revealed that the major fatty acids were oleic, linoleic, and palmitic acids (44.11%, 34.77%, and 15.97% respectively). Seed oil was also found to be rich in tocopherols with a predominance of δ-tocopherol (42.27%). The sterol marker β-sisosterol accounted for 39.6% of total sterols contained in seed oil of this variety. Six phenolic acids (protocatechuic, caffeic, syringic, p-coumaric and ferulic) were detected, the syringic acid being predominant (7.96 mg/100 g). As a whole, based on its seed oil features, pumpkin may be considered as a valuable source for new multi-purpose products for industrial, cosmetic, and pharmaceutical utilization.

Cucurbita pepo can be eaten raw in salads or stir-fried, batter fried, steamed, or cooked in a variety of additional ways including such things as zucchini breads. Summer squash blossoms are excellent in

soups and stews, sautéed, stuffed, or dipped in batter and fried.

The shells of well-ripened fruits of *Lagenaria siceraria*, often called calabashes, are water-tight, very hard and durable. The fruits also come in a variety of shapes and sizes. This has made them extremely popular with native people all round the world who use the calabashes to store and transport all manner of items, including foods, seeds and grains, drinks and other liquids etc. *Lagenaria siceraria* are also used to make various different musical instruments, beehives, barrels for brewing, buckets for drawing water, plates, bowls, cups, ladles etc - the list could go on and on and is only limited by the imagination. *Lagenaria siceraria* are also used as children's toys, and for decorative purposes, when they are often intricately ornamented before being sold.

Luffa is primarily grown for its fiber production. The young fruits and leaves can be cooked as a vegetable (fruits are used in India to make curry) or eaten fresh or dried. When the fruit matures it becomes fibrous: the fiber is used as a sponge for washing by humans and scrubbing tools. In Central Africa, *luffa* fiber is used to brush clothes. It is also used to make hats, insoles of shoes, car-wipers, mats, sandals and gloves. The fiber has shock and sound absorbing properties that can be used in helmets and armored vehicles. The fibre can be used as a filter in engines or to treat water or, in Ghana, palm wine. Fungal biosorbents can be immobilized on cylindrical sponges made of *luffa* in order to absorb heavy metals from wastewaters, including those from olive oil mills. *Luffa* oil meal is suitable as a fertilizer (Achigan-Dako et al., 2011).

Luffa seeds can be extracted for their edible oil which is rich in linoleic acid and has a high unsaturated: saturated fatty acids ratio (Elemo et al., 2011). However, *luffa* seeds and oil meal contain bitter substances that may be toxic to livestock. As of 2014, successful use of *luffa* products has only been reported for *luffa* seeds in feeding rabbits (Dairo, 2008), and *luffa* oil meal for feeding African catfish (*Clarias gariepinus*) (Jimoh et al., 2013). The use of *luffa* oil meal was considered inadvisable for cattle (Achigan-Dako et al., 2011).

Luffa fruits and foliage are palatable and browsed by goats (Achigan-Dako et al., 2011; El-Hag et al., 2013). Leaves can be eaten by horses, cattle, sheep and goats (Malzy, 1954). Ridge gourd is low in saturated fat and cholesterol, high in dietry fibre, vitamin C, riboflavin, zinc, thiamin, iron, magnesium and manganese. Fresh fruit weighing 100 g contains 95.2 g moisture, 0.5 g protein, 0.1 g fat, 0.5 g minerals (18 mg calcium, 26 mg phosphorus, and 0.5 mg iron), 0.5 g fibre, 3.4 g carbohydrates, 0.01 mg riboflavin, 0.2 mg niacin and 5 mg vitamin C. (Dhaliwal, 2107) (figure 1, 2 and 3).

Momordica charantica, according to different studies, is a good source of vitamins A, B1, B2 and C. The species is remarkable thanks to its appreciable amounts of minerals like calcium, phosphorus, iron, copper and potassium. Per 100 grams of fresh fruit (Dhaliwal, 2107) reported 92.4 g moisture, 1.6 g protein, 0.2 g fat, 4.2 g carbohydrates, 0.8 g fibre, 20 mg calcium, 70 mg phosphorus, 0.6 mg iron, 88 mg vitamin C and 0.5 mg niacin. (figure 1, 2 and 3). The major chemical constituents of *Momordica charantica* are classified as:

(i) heteropolysaccharides, mainly composed of galactose, glucose, arabinose, rhamnose, and mannose; (ii) proteins and peptides, such as momordins, momorcharins, MAP30 and MC lectin, belonging to the ribosome-inactivating proteins family (RIPs) (Schrot et al., 2015); (iii) terpenoids and saponins, such as cucurbitanes and cucurbitacines; (iv) flavonoids and phenolic compounds; (v) other compounds such as essential oils, fatty acids, amino acids, and sterols (Dandawate et al., 2016).

Nutritional analysis demonstrated that this plant possesses the highest nutritive value among cucurbits, being a good source of carbohydrates, proteins, fibers, vitamins, and minerals. Fruits are composed by 93.2% of water, while protein and lipids account for 18.02 and 0.76% of its dried weight, respectively (Saad et al., 2017). Green fruits contain vitamin C, A and P, thiamine, riboflavin, niacin, and minerals (Gupta et al., 2011). In addition, *Momordica charantica* seeds can represent a good source of lipids, such as polyunsaturated fatty acids (nearly 45% of the weight) and they are among the few foods containing conjugated linolenic acid, being 63–68% as eleostearic acid (Yoshime et al., 2016). The essential oil, obtained from drought seeds, contains sesquiterpenes, phenylpropanoids and monoterpenes.

Other bioactive compounds, such as tocopherols and polyphenols have been reported in *Momordica charantica* seed oil (Nyam et al., 2013). The pericarp, the aril, the stem and the leaves of the plant are also a good source of phenolic compounds, which can be useful to protect from oxidative damage by acting directly on reactive oxygen species and to induce endogenous defense systems (Yoshime et al., 2016).

Several glycosides isolated from *Momordica charantica* fruit and stem have been grouped as cucurbitane-type triterpenoids, being cucurbitacins the main ones. They exhibit a broad range of biological activities, mainly anti-inflammatory and anti-diabetic (Rios et al., 2005).

It’s a well-known fact that bitter gourd cures adult onset diabetes (occurring in people who are overweight and passive.). Several researches proved that it contains a hypoglycaemic or insulin-like principle, designated as 'plant-insulin', which has been found highly beneficial in lowering the blood and urine sugar levels. *Momordica charantica* juice finds use in antiviral and antibacterial herbal therapy.

Several investigations carried out revealed that a biomoiety called MAP30, has been found effective in neutralizing impact of carcinogens meant to generate benign tumors, and diminish HIV and herpes. *Momordica charantica* is quite low in calories with a 100 gram serving, providing just 17 calories. *Momordica charantica* is an excellent source of vitamin C with 100 grams of raw pod, providing 84 mg, equivalent to 140% RDI. Few vitamins viz. niacin, pantothenic acid and pyridoxine, have also been found in traceable quantity in bitter gourd. Authenticity and functionality of therapeutic worth of this bitter fruit has been delineated in this manuscript precisely.

The study involved an investigation on fruit yield capacity of cultivated *Cucurbitaceae* in order to be used as medicinal. Figure 4 presented the average value for achieved fruit yield by each species. For each species a number of three accessions were investigated. The experimental plots were established in condition of ecological agriculture taking in account the use as medicinal. No chemical treatments were applied.

CONCLUSIONS

Cucurbitaceae species represent a valuable source of food, medicinal and other purposes. This review covered the analgesic, anti-inflammatory, anti-infectious, antipyretic, laxative and purgative effects of the investigated medicinal potential. The study demonstrates the importance and the need of continuity of investigation in order to detect and select the most suitable plant genetic resources for each purpose of use.

The study highlight the medicinal potential of different cucurbits organs: roots (diuretic and emetic effects), flowers (expectorant and emetic effect), seeds (antitussive, vermifuge, digestive, effect against fever), fruits (facilitate digestion, diuretic effect, the treatment of burns and other plagues; dental pain, diet of people with heart disease, anticarcinogenic capacity; maintaining corneal health and improving night vision, controlling high blood).

ABSTRACT

In last decades, when many diseases were associated to lifestyle, especially to food quality, researcher attention was guided to find alternative sources in nature. Nowadays, a large range of crops has been identified to play an important role in different industries as follows: food, pharmaceutics, cosmetics, medicinal, decorative etc. *Cucurbitaceae* species are valuable resources thanks to their nutritional quality.

The chemical content of *Cucurbitaceae* species allows mainly the usage of fruits, seeds, flowers as raw material for multiple purposes. The aim of paper was to present a part of *Cucurbitaceae* genetic resources in order to highlight the enormous potential of species to be used in different purposes as food, medicinal, decorative. The paper presents a list of spontaneous and cultivated *Cucurbitaceae* in Romanian region, used as medicinal, food and decorative. Our study provides information about their traditional medicinal use. In investigated region, *Cucurbitaceae* species are cultivated mainly for their use as vegetables and spices. For species falling under the genera *Lagenaria, Cucurbita, Citrullus, Luffa, Momordica* the study presented information related to nutritional profile and yield potential of the most valuable cucurbit genetic resources included in our breeding programs.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian Ministery of Research and Innovation, CCCDI - UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0850/ contract 14 PCCDI /2018, within PNCDI III", and presented in frame of FARMRES Conference

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