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Artículo de Revisión / Review Article

Pumpkin seeds (Cucurbita maxima). A review of functional attributes and by-products

Semillas de calabaza (Cucurbita máxima). Una revisión de sus propiedades funcionales y sub-productos

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ABSTRACT

The need to obtain nutritious foods from new sources and lower waste in industry has created a high interest in studying different parts of plants or foods that today are considered waste, but could be considered by-products with high nutritional value with potential use in human diets. Pumpkin seeds are commonly considered as waste but they have a high content of fatty and amino acids, which when used as a by-product or ingredient can add value to food products. The aim of this work was to perform a wide review of the nutritional and functional properties of Cucurbita maxima seeds and their potential medicinal influence.

Keywords: By-products; Cucurbita maxima; Functional foods; Pumpkin; Unsaturated fatty acids.

RESUMEN

La necesidad de obtener alimentos nutritivos de nuevas fuentes y menores desperdicios en la industria ha generado un gran interés en el estudio de diferentes partes de plantas o alimentos que hoy en día se consideran desechos, pero que podrían considerarse subproductos con alto valor nutricional y uso potencial en alimentación humana. Las semillas de calabaza se consideran comúnmente como desechos, pero tienen un alto e importante contenido de ácidos grasos y aminoácidos, que cuando se utilizan como subproducto o ingrediente pueden aportar un alto valor agregado a los productos alimenticios. El objetivo de este trabajo es realizar una amplia revisión de las propiedades nutricionales y funcionales de las semillas de Cucurbita maxima y su potencial influencia medicinal asociada a ellas.

Palabras clave: Ácidos grasos insaturados; Alimentos funcionales; Calabaza; Cucúrbita máxima; Sub productos.

INTRODUCTION

In the last decades, the demand for new nutritionally healthy and sustainable viable foods has increased considerably. Therefore, special attention has been given to the utilization of by-products. The uses of these raw materials add value to economic production, contributes to the formulation of new food products and minimize waste[1].

Cucurbita maxima, commonly known as pumpkin belongs to the Cucurbitaceae family. It is native of South America and is mainly grown in Brazil with an estimated production of 3600 tons in 2006 alone in the town of Puente Alto, Santa Catarina[2]. For its part, in Chile is widely known as “zapallo camote” o “zapallo de guarda” and is the seventh most cultivated crop in Chile and represents, since ancient times, an important source of food for the population[3].

Despite its great agronomic potential their use in Chile is mainly destined to the preparation of traditional Chilean meals and seeds are wasted[4], while in some parts of Africa and Brazil pumpkin seed are used as a food supplement. Also, these seeds are consumed both toasted and salted in Greece[5], while in Austria, the extracted oil from seeds is used as salads seasoning because of its aroma and flavor[6].

When dried, seeds can be used as a thickener for soups and as snacks[7].

One of the measures taken to improve the nutritional status of the population includes the use of plant by-products, based on utilization of plant parts that are wasted. Into these products, there is the use of pumpkin seeds, which are characterized by high levels of protein and oil[1,2,3,4,5,6,7,8].

Several beneficial effects to human health have been attributed to pumpkin seeds, due to their macro and micronutrient content[9]. Pumpkin seeds are a natural source of phytosterols and antioxidants vitamins such as tocopherols and carotenoids[10,11] and an excellent source of unsaturated fatty acids such as oleic and linoleic[12]. These compounds are attributed to have physiological activity beneficial to the prostate and others such as being antiparasitic for the intestine (anthelmintic, vermifuge and tenifuge activities)[13]. Because of these beneficial effects on human health, pumpkin seeds can be considered as a natural functional food.

On the other hand, nowadays nutrition is experiencing quick changes aimed at the relationship between food intake and chronic non-transmissible diseases. Moreover, there is increased interest in the effects of nutrition on cognitive and immune functions, work capacity and physical performance. This, plus the great interest of consumers are placing more value on health and wellness, makes "healthy" or functional foods an important issue in current human eating[14].

Functional foods have been defined as a new range of different foods containing biologically active ingredients such as phytochemicals, antioxidants, fatty acids and other compounds presents in fruits, vegetables and seeds. When functional foods are included in diet important benefits to consumer´s health are provided[15]. Cucurbita maxima seeds are among the seeds that are highly wasted, but can be considered a functional food. Thus, composition, nutritional benefits of consumption, by-products and the technical feasibility of them are studied in this paper. The aim of this work was to disseminate nutritional and functional characteristics of seeds from the species of Cucurbita maxima and the medicinal properties associated with them.

General background

Crop

The pumpkin is grown in warm climates from 20 to 27 °C, as it is a sensitive product to cold and frost[3]. In Chile, the cultivation area is located in the central region and the northern center of the country, especially the Metropolitan, Libertador Bernardo O'Higgins, Maule and Coquimbo regions. The Cucurbita maxima fruit is harvested during the months of March and April, when the ripe fruit can be properly stored for several months under conditioned cellars and reception centers, which allow the product to be stocked throughout the whole year[16].

Taxonomy

The family of Cucurbitaceae has around 118 genus and more than 825 species[17]. The taxonomy classification of Cucurbita maxima is shown in the table 1.

Botany

It is important to know the botany of the maximum Cucurbita species in order to understand the differences and procedures for obtaining its by-products. Botany gives very important information from at the macroscopic level, structure and function of a vegetable. Thus, the plant will be described to understand its main by-product, the seeds.

Plant

Cucurbita maxima is a yearly, herbaceous diclino-monoecious plant. The plant has a radial system that reach a profundity of 1.8 m, but most of it is in the first 60 cm. The stems are rough, often angular, with tendency to produce roots in the knots. There are creeping stems with guides between 10 and 30 m long, have semierect stems (trunk varieties) with short internodes. The leaves of the Cucurbita maxima are large, suborbicular, frequently lobed rounded and single-layered[18].

The flowers are yellow, commonly solitary, and occasionally the masculine ones are in fascicles. The male flowers have long peduncles, three stamens, free filaments, linear anthers, connivent, one of them being monothecae. The female flowers are short pedunculate, with an inferior, oblong or unipolar ovary, with 3-6 pluriovulated placentas, shirt styled and 3-5 lobed stigma. During pollination (of entomophily form) the stigma remain open and with receptive stigma for 12 hours[18].

The fruit is a berry (unilocular with many seeds), indehiscent, of various size and coloration. It has an inner cavity where fibers and seeds are located[18].

Seeds

The seeds are large, flat, oval-shaped and end in a tip. They have an approximate weight between 50 and 250 mg as well as small and big fruits. The large size provides an excellent reserve that favors the germination and establishment of the seeds[18].

Mature seeds do not contain functional endosperms. The embryo completely fills the seed coat and the reserves (in the form of lipids, in small spherical bodies called spherosomes, and proteins in protein organelles) are stored in the cotyledons[18]. The optimum temperature for germination ranges from 25 to 30 ºC and it is inhaled below 15 ºC[18].

Chemical composition of pumpkin seeds

In relation to pumpkin seeds (Cucurbita maxima), the moisture content can vary by variety and regions. The seeds var. Béjaoui showed a moisture content of 8.46%[19], while a slightly low values between 3.08 and 5.40%, were showed for seeds collected from Akure, Ondo State in Nigeria and the province of Didymotikhon Evros, Greece, respectively[20,21]. Cucurbita maxima seeds present nutritional composition mainly characterized by a high concentration of fatty acids and proteins[11]. Cucurbita maxima seeds present nutritional

Figure 1: Flower and fruit.

Figure 2: Cucurbita maxima seed.

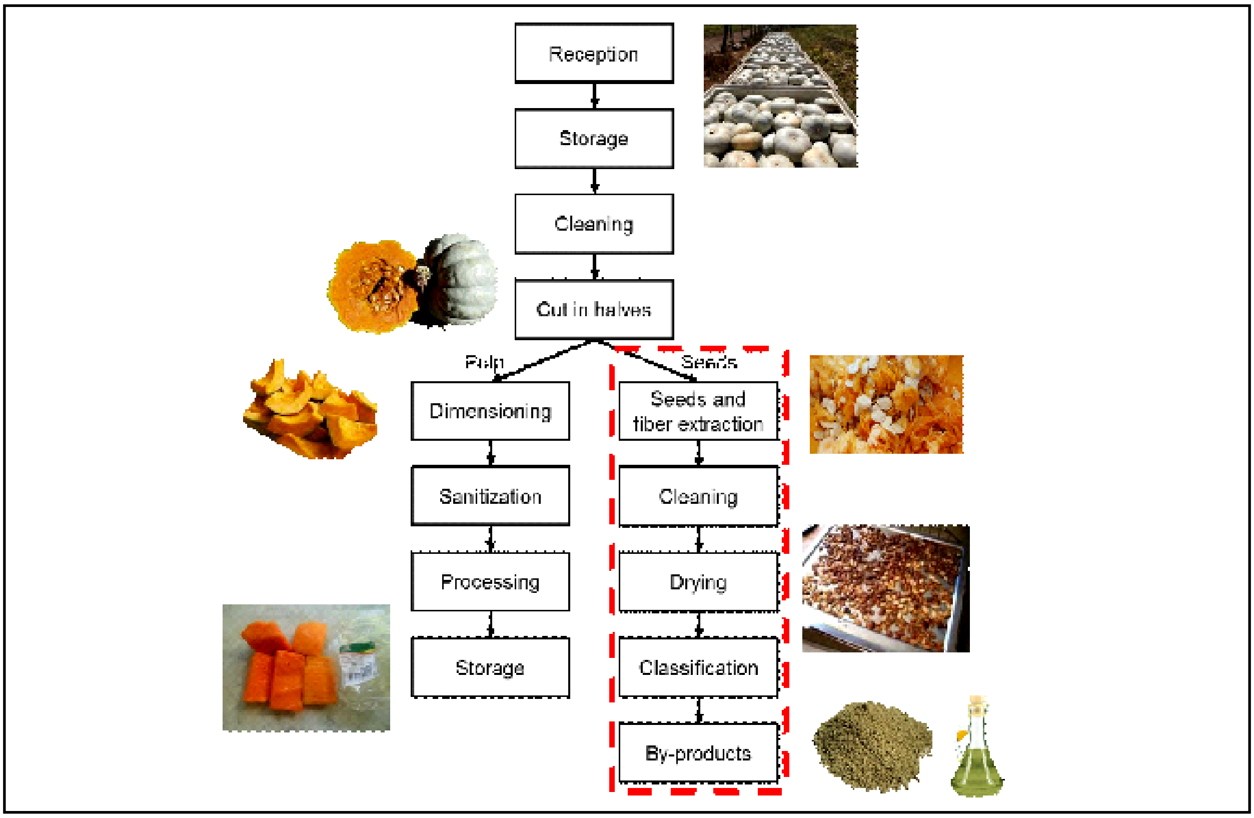

Figure 3: The diagram represents the industrial treatment process of pumpkin and the precise stage in which the seeds are separated for obtaining by-products.

Table 1. Taxonomic Hierarchy of Cucurbita maxima Duchesne.

Kingdom	Plantae- Plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta- land plant
Superdivision	Embryophyta
Division	Tracheophyta- vascular plants, tracheophytes
Subdivision	Spermatophytia- spermatophytes, seed plants, phanérogames
Class	Magnoliopsida
Superorder	Rosanae
Order	Cucurbitales
Family	Cucurbitaceae- gourds, squasches, citrouilles, gourdes
Genus	Vuvurbita L.- gourd
Species	Cucurbita máxima Duschesce- Winter squash
Subspecies (direct Children)	Cucurbita máxima ssp. Andreana (Naudin) Filov- wimter squash
Subspecies (direct Children)	Cucurbita máxima ssp. Máxima Duchesne

Source: (ITIS 2017).

composition mainly characterized by a high concentration of fatty acids and proteins[11]. Table 2 shows the nutritional composition reported in different articles on Cucurbita maxima seed[20,21,22]. Based on this evidence, seeds have a high nutritional value, provide good quality oil and tocopherols and have a good vegetable cover[27].

Regarding proteins contained in Cucurbita maxima seeds, the presence of amino acids is noteworthy, with glutamic acid and arginine being the most abundant[22,23,24] (Table 3). Moreover, species belonging to the Cucurbitaceae family have an unusual amino acid known as cucurbitin, chemically defined as (-)-3-amino-3-carboxipirrolidine; and is attributed to anti-inflammatory and antiparasitic functional properties[25].

Ash content is also high and is mainly characterized by the presence of key minerals that are generally deficient in food intake such as zinc, iron and manganese[19,20,22]. Table 4 shows the mineral content of Cucurbita maxima seeds. The differences observed could be explained by soil conditions, seed status, and mineral determination methodology, among others.

Fatty acids content in Cucurbita maxima seeds is up to 50% of total weight of the seed[20], with predominance of unsaturated-short chain fatty acids. As a result, seeds have a high stability to oxidative rancidity process, which is also coincident with a low peroxide value, as can be appreciated in table 5[20]. Peroxide value is used as an indicator of oil deterioration and acid value is used as an indicator of oil edibility[20]. These values change according to the place of origin and the references analyzed.

The saponification index of the oil could be used as a parameter for checking adulteration of the oil sample[20]. The saponification index, varying from 126 to 201, shows that among fatty acids present in the examined oils, these have a higher number of carbon atoms. The oils have high iodine values, thus reflecting a high degree of unsaturation. In addition, high values indicate that the oil has a high content of unsaturated fatty acids relative to palm oil[22,23,24,25,26,27]. As mentioned, oil extracted from Cucurbita maxima consists mainly of stearic, oleic and linoleic acids, among other, as it can be observed in table 6.

A study carried out by Stevenson[11] evaluated seed oil content and fatty acid composition of twelve pumpkin cultivars (Cucurbita maxima D.) grown in Iowa. Oil and total unsaturated fatty acid content ranged between 10.9-30.9% and 73.1-80.5%, respectively. The predominant fatty acids were linoleic, oleic, palmitic, and stearic acid. The range of fatty acid composition was shown in table 6[11,19,21].

Phytosterols are usually classified as d-7 and d-5 sterols, with d-7 sterols predominant in pumpkin oil seeds[28]. Tocopherols content in Cucurbita maxima oil extract varied from, as follows: between 27,1-75,1 μg/g oil for α-tocopherol; 74,9-492,8 μg/g γ-tocopherol oil; and 35,3-1109,7 μg/g δ-tocopherol oil.

This fact about tocopherols composition in Cucurbita maxima seeds is the reason for high oxidative stability and makes Cucurbita maxima oil a good choice to use in industrial applications and to incorporate into human diet[11].

Table 2. Proximal composition of Cucurbita maxima seeds.

Component	100 g			
	Amoo et al. 2004	Alfawaz, 2006	Lazos, 1986	Rezig, Chouaibi, Msaada, & Hamdi, 2012
Moisture content (%)	3.08	5.97	5.40	8.46
Energy (kcal)	628	453	676	455
Crude proteins (g)	14.31	39.25	32.3	33.92
Crude Fat (g)	52.13	27.83	45.4	31.57
Carbohydrates (g)	24.45	11.48	5.55	0.11
Crude Fiber (g)	2.55	16.84	12.1	21.97
Total ash (mg)	3.60	4.59	4.65	3.97

Table 3. Comparison of amino acid % composition of pumpkin seed Cucurbita spp and Curcubita maxima.

Amino acid	Curcubita spp. Glew et al. 2006	Curcubita máxima Alfawaz, 2004
Alanine	3.7	5.12
Arginine	16.4	15.80
Aspartic acid	9.0	9.56
Cysteine	1.1	-
Glutamic acid	17.9	23.23
Glycine	4.2	6.01
Histidine	2.4	2.66
Isoleucine	3.9	3.59
Leucine	6.9	7.25
Lysine	3.8	3.71
Methionine	2.1	1.83
Phenylalanine	5.5	5.29
Proline	3.4	-
Serine	5.2	5.85
Theronine	3.1	3.04
Thryptophan	2.7	1.10
Tyrosine	3.9	3.26
Valine	4.7	4.45

Nutritional benefits of pumpkin seeds

There are several uses and applications of pumpkin by-products. For Curcubita maxima, the seeds can be used for oil and flour. Its application focuses on providing added value from the nutritional point of view for human and animal feeding. What follows is a summary of the research regarding the nutritional capacity of seeds and pumpkin shells.

Table 4. Mineral content of Cucurbita maxima seeds.

Mineral	Seed Amount (mg/100 g)		
	Amoo et al. 2004	Alfawaz, 2004	Rezig et al. 2012
Sodium	29.69	68.58	356.75
Potassium	35.87	753.11	886.56
Magnesium	34.87	364.43	146.13
Calcium	29.47	139.70	271.89
Phosphorus	224.14	1036.82	824.53
Manganese	1.79	-	3.42
Zinc	3.98	1.09	25.19
Iron	4.27	13.66	15.37

Direct consumption of pumpkin seed has had a high demand. One study found that the consumption of dietary milled sesame/pumpkin/flax seed among hemodialysis patients lowers markers of inflammation, such as triglycerides[29].

Pumpkin (Cucurbita maxima) seeds and plant seeds belonging to the Cucurbitaceae family are edible, abundant and big. However, they are mostly discarded as agro-industrial waste, except for certain of these seeds that have been used in folkloric and traditional medicine as a remedy for kidney, bladder and prostate disorders[30].

Pumpkin seed oil has diverse phenolic compounds such as tyros (phenylethanoid), vanillic acid, vanillin, luteolin and sinapic acid. When administered to mice, the oil stressed with aflatoxin, lowered the toxic effect of the mycotoxin. The supplementation of pumpkin seed oil also attenuated the cytotoxicity and genotoxicity of the immunosuppressive agent azathioprine and restored the glutathione content and DNA integrity following supplementation[30].

Table 5. Physicochemical characterization of pumpkin seed oil.

Parameter	Value			
	Amoo et al. 2004	Regiz et al. 2012	Tsaknis, Lalas, & Lazos, 1997	Regiz et al. 2012
Refractive index	1.45	1.46	1.46	1.46
Saponification value	126.09	175	201	199.3
Peroxide value	2.80	2.33	9.20	-
Acid value	0.36[a]	7.54[a]	0.97[b]	0.9[b]
Iodine Value	18.66	153.66	107	103.20
Specific gravity	0.94	0.91	–	–

[a]: mg KOH/g oil. [b]: Acidity, % as oleic.

Table 6. Fatty Acid Composition of Cucurbita maxima seed oil.

Fatty Acids	Percent weight
Saturated	
C14:0 Myristic	0.09-0.25
C16:0 Palmitic	12.6-18.4
C18:0 Stearic	4.68-9.0
C20:0 Arachidic	0.26-1.12
C22:0 Behenic	0.12-0.54
Monounsaturated	
C16:1 Palmitoleic	0.10-0.52
C18:1 Oleic	17-44.11
Polyunsaturated	
C18:2 linoleic	34.77-62.8
C18:3 n-6 linolenic	0.3-0.82

Source: Rezig et al., 2012; Stevenson et al., 2007; Lazos, 1986.

Consumption of pumpkin seed reduces markers of inflammation, increases lymphocyte count, enhances phagocytic activity, and inhibits the progression of fatty liver to steatohepatitis (determined from low MDA and TNF-α content)[30]. Supplementation of pumpkin seed oil has cardioprotective, hypolipidemic, antihypertensive, hypoglycemic, anthelmintic and wound healing effects. Oral intake of Cucurbita maxima seed oil extract in doses of 10 g/day for 6-12 weeks reduces the bladder over-activity of patients preventing urinary disorders and producing an effect on urinary health[30], also it causes inhibition of formation of crystals and aggregation on urinary tract, thus decreasing the risk of bladder and kidney calculus[31].

Lipid extract from Cucurbita maxima seeds slows the progress of hypertension and decreases hypercholesterolemia because of the unsaturated fatty acids and phytosterols content. Moreover, there is evidence that seeds can decrease the risk of diabetes, promotes hypoglycemic activity[32], and decrease levels of breast, gastric, colon-rectal and pulmonary cancers[33]. Furthermore, Cucurbita maxima seeds have been used in traditional medicine as a vermifuge and their consumption in the raw and roasted form helps relieve abdominal pain produced by intestinal parasites[31].

Use and application of pumpkin seeds by-products: oil

Pumpkin seed oil is rich in various bioactive compounds including unsaturated fatty acids, sterols, tocopherols, squalene and carotenoid pigments[11] and it has been recognized for several health benefits such as the prevention of growth and reduction of prostate size, the slowing of hypertension progression, mitigation of hypercholesterolemia and arthritis, reduction of bladder and urethral pressure and improving bladder compliance, alleviation of diabetes by promoting hypoglycemic activity, and lowering levels of gastric, breast, lung, and colorectal cancer[11,20]. In addition, Morrison[34] showed that the substitution of saturated dietary oil with pumpkin seed oil was related to the amelioration of metabolic and cardiovascular disease.

Nishimura[35] studied the effect of seed oil on urinary dysfunction in human overactive bladder associated with age. Results indicated that the Cucurbita pepo variety proved to be useful for the nocturnal treatment of patients with urinary disorders in several western countries. The diurnal frequency, night frequency, urgency and urgency incontinence of the subjects under investigation were evaluated. Pumpkin seed oil of Cucurbita maxima significantly reduced the degree of overactive bladder symptoms in subjects[35].

Use and application of pumpkin seeds by-products: Flour

One of the most common ways to reuse pumpkin waste is flour, which can be obtained from both the seeds and peel. Pumpkin shells present a high protein and fiber content, in addition to ascorbic acid and calcium, which presented relevant concentrations compared to the pulp, a commonly consumed part[36]. Therefore, the use of the pumpkin peel in flour production can lead to better nutrient exploitation. Burger[37] obtained pumpkin hull flour and as a technological application, made bread from this flour in order to partially replace wheat flour. The bread was made with 2.5% and 5% concentration of pumpkin hull flour. The use of pumpkin flour increased the total protein content in the bread, an attractive characteristic from the nutritional point of view; however, there was a small decrease in bread attributes such as cohesiveness, volume and elasticity, which was expected due to the low formation of gluten.

Likewise, the partial replacement of wheat flour for pumpkin seed flour in muffins for children was studied with positive results. As the substitution of wheat flour for pumpkin seed increased, the nutritional value of muffins improved. Increasing pumpkin seed meal content caused a decrease in saturated short chain fatty acids in the muffins. In addition, the partial replacement of wheat flour with pumpkin seed flour induced a decrease in long chain main saturated fatty acid content from extracted muffin fat (C14:0-myristic, C16:0-palmitic and C18:0-Stearic FA). Moreover, when sensorially properties were evaluated, over 71% of the children reported that muffins with a 33% of pumpkin seed flour were “tasty” and “very tasty”, for muffins stored for two weeks without special condition packaging[38].

Pumpkin seed flour is not only used as food alternatives for humans, but also as animal feed, which can have a positive impact on the animal. Cerqueira[39] evaluated the effect of pumpkin seed flour on glucose and lipid metabolism in rats, resulting in a significant decrease in glucose and triglyceride levels in the groups that consumed food that including whole and sifted pumpkin seed meal, without influencing growth. On the other hand, Martinez[40] analyzed the inclusion effect of squash seed meal on cholesterol and fatty acids of laying hens and their eggs. The fatty acids concentration increased in eggs due to added flour: octadecanoic (152 to 450 mg/100 g), oleic (1282 to 1918 mg/100 g), linoleic (22 to 667 mg/100 g), α-linolenic (457 at 649 mg/100 g); while reducing the amount of arachidonic acid (62 to 50 mg/100 g). Total cholesterol was also decreased by 28 to 30 mg/egg with respect to the control, thus enriching the egg.

In another study, combining both types of by-products, squash waste (husk, fruit fractions and seeds) was incorporated into an extruded snack product under different concentrations along with corn grains. Color, expansion ratio, bulk density, texture and rheological attributes were analyzed for an extruded product, obtaining optimal results with 10% flour[41].

Extraction methods to obtain by-products

Conventional methods for extraction of oil from oilseeds are mainly based on the use of expeller pressing and organic solvent extraction (mainly hexane), which may result in high investment costs, human health hazards and unacceptable environment contamination[42]. In this sense, several green and economical methods have been designed to supersede the conventional ones, as table 7 shows. Supercritical CO_2 extraction (SFE-CO_2) avoids the use of organic solvents and large waste streams, but the system is complicated and expensive[43]. Aqueous enzymatic process for oil extraction is undoubtedly an emerging technology in the fats and oil industry since it offers many advantages such as cost savings, environmental friendliness, and healthy nutrition[44].

Table 7. Green method extraction to obtain oil from pumpkin seeds.

By-product	Process	Optimal extraction conditions	Maximum yield	Source
Oil	Supercritical carbon dioxide (SC-CO_2)	32.140kPa; 68.1 °C; 94.6min	30.70%	(Mitra, Ramaswamy et al. 2009)
	Microwave-assisted aqueous enzymatic extraction	1,4%p/p enzyme; 44 °C; 66min, 419W	64.17%	(Jiao, Li et al. 2014)
	Cavitation system to accelerate aqueous enzymatic extraction	1.05% p/p enzyme; -0.07 vacuum degrees; 69min.	58,06%	(Li, Li et al. 2016)
	Ultrasound	Amplitude of 89.02%, 26.34min	62.46%	(Hernández-Santos, Rodríguez-Miranda et al. 2016)

To enhance seed oil extraction efficiency, diverse accelerated enzyme-catalyzed reaction technologies are available. Apart from the methods such as microwave[45], ultrasound[46], high pressure[47], extrusion[48] and electrical discharge[49], there is some work on negative pressure cavitation systems for accelerated enzyme-catalyzed reaction.

Technical feasibility and processing

Development of a by-product from pumpkin seeds could give a high added value to different food products along with reducing waste and losses for manufacturers. This can be approached by processing the food commodity to support small producers and add activities for small and medium enterprises. Furthermore, a supply chain of three or more entities can also be directly involved in the upstream and downstream flows of products, services, finances and/ or information from a source to a customer.

Bahinipati[50] reviewed supply chain planning and focused on short-life products in a competitive marketplace. They found that this supply chain integrates a complex network of farmers and food processors to supply customers and enhance operational effectiveness. According to Fleming and Speare[51], production of dehydrated vegetable powders could permit expanded production of vegetables by providing additional market opportunities for farmers. They note that pumpkin, as a perishable product, could be sold immediately to the fresh produce market, partially processed as puree and/or dehydrated products that can have a high shelf-life and stability during an extended time in markets. The result of a trial conducted by Chan[52] on proportion of pumpkin fractions showed that the flesh made up of 79% of pumpkin total weight, while pulp and peel consisted of 15% and 6% seeds.

CONCLUSION

The edible Cucurbita maxima seeds, which conventionally get discarded, can be put to good use. They are nutrient-dense and can be used for diverse applications such as enriching food products and bioactive compound extraction. Thus, these seeds can be considered as a functional food thanks to the multiple benefits on human health. This review may stimulate research on these seeds and other biological potentials associated with them.

REFERENCES

1. *Naves L, Correa A, Santos C, Abreu C. Nutrientes e propriedades funcionais em sementes de abóbora (Cucurbita maxima) submetidas a diferentes processamentos. Ciênc Tecnol Aliment 2010; (30): 185-190.*
2. *ABH - Associação Brasileira de Horticultura 2008; Accessed May 10, 2018. http://www.abhorticultura.com.br.*
3. *Valencia M. Tesis Situación actual y perspectivas del zapallo chileno camote (Cucurbita maxima Duch): germoplasma, prácticas agronómicas y análisis económico del cultivo. Valparaíso, Chile: Facultad de Agronomía PUCV, 2006.*
4. *Bascur G. Nuevas Variedades de Zapallo de Guarda para el Consumidor Chileno. Tierra Adentro 2005;Nov- Dic:38-39.*
5. *Lazos E, Tsaknis J, Bante M. Changes in pumpkin seed oil during heating. Grasas Aceites 1995; (46): 233-239.*
6. *El-Adawy T, Taha K. Characteristics and composition of watermelon, pumpkin and paprika seed oils and flours. J Agric Food Chem 2001; (49): 1253-1259.*
7. *Achu M, Fokou E, Tchiégang C, Fotso M, Tchouanguep F. Nutritive value of some Cucurbitaceae oilseeds from different regions in Cameroon. Afr J Biotechnol 2005; 4(11): 1329-1334.*
8. *Castro H, Galvez M, González S, Villamil C. Protein composition of Cucurbita maxima and C. moschata seeds. Biol Plan 2006; 50(2): 251-256.*
9. *Xanthopoulou M, Nomikos T, Fragopoulou, E., Antonopoulou, S. Antioxidant and lipoxygenase inhibitory activities of pumpkin seed extracts. Food Res Int 2009; (42): 641-646.*
10. *Ryan E, Galvin K, O'connor T, Maguire A, O'brien N. Phytosterol, Squalene, Tocopherol Content and Fatty Acid Profile of Selected Seeds, Grains, and Legumes. Plant Foods Hum Nutr 2007; (62): 85-91.*
11. *Stevenson D, Eller F, Wang L, Jane J, Wang T, Inglett G. Oil and Tocopherol Content and Composition of Pumpkin Seed Oil in 12 Cultivars. J Agric Food Chem 2007; 55(10): 4005-4013.*
12. *Applequist W, Avula B, Schaneberg B, Wang Y, Khan I. Comparative fatty acid content of seeds of four Cucurbita species grown in a common (shared) garden. J Food Compost Anal 2006; (19): 606-611.*
13. *Díaz D, Lloja L, Carbajal V. Preclinical studies of cucurbita maxima (pumpkin seeds) a traditional intestinal antiparasitic in rural urban areas. Rev Gastroenterol Peru 2004; 24(4): 323-327.*
14. *Araya H, Lutz M. Alimentos funcionales y saludables. Rev Chil Nutr 2003; 30(1): 8-14.*
15. *Soto D, Wittig, E, Guerrero L, Garrido F, Fuenzalida R. Alimentos Funcionales: Comportamiento del Consumidor Chileno. Rev Chil Nutr 2006; 33(1): 43-54.*
16. *Martínez Y, Valdivié M, Solano G, Estarrón M, Martínez O, Córdova J. Efecto de la harina de semilla de calabaza (Cucurbita maxima) en el colesterol total y ácidos grasos de los huevos de gallinas ponedoras. Rev Cuba Cienc Agric 2012; 46(1): 73-78.*
17. *Lira R, Rodríguez A. Cucurbitaceae. Catálogo de La Familia Cucurbitaceae de México. Unidad de Biología, Tecnología y Prototipos, FES Iztacala, Base de Datos SNIB-Conabio DS002.*
18. *Sinavimo. Sistema Nacional Argentino de Vigilancia y Monitorio de Plagas. Cucurbita máxima 2017; Accessed November 6, 2017. http://www.sinavimo.gov.ar/cultivo/cucurbita-maxima.*
19. *Rezig L, Moncef Ch, Kamel M, Salem H, Chemical composition and profile characterization of pumpkin (Cucurbita maxima) seed oil. Ind Crops Prod 2012; 37(1): 82-87.*
20. *Amoo I, Eleyinmi A, Ilelaboye N, Akoja, S. Characterization of oil extracted from gourd (Cucurbita maxima) seed. J Food Agric Environ 2004; 2: 38-39.*
21. *Lazos E. Nutritional, fatty acid, and oil characteristics of pumpkin and melon seeds. J. Food Sci 1986; 51(5): 1382-1383.*
22. *Alfawaz M. Chemical Composition and oil characteristics of pumpkin (Cucurbita maxima) seed kernels. Food Sci Agric Res 2004; 129: 5-18.*
23. *Younis Y, Ghirmay S, Al-Shihry S. African Cucurbita pepo L. properties of seed and variability in fatty acid composition of seed oil. Phytochem 2000; 54(1): 71-75.*
24. *Glew R, Glew, RH, Chuang L, Huang Y, Millson M, Constans D, Vanderjagt D. Amino acid, mineral and fatty acid content of pumpkin seeds (Cucurbita spp) and Cyperus esculentus*

nuts in the Republic of Niger. Plant Foods Hum Nutr 2006; (61): 51-56.

25. Salama A. Las Cucurbitáceas, Importancia Económica, Bioquímica y Medicinal. Ed. Unibiblos. Bogotá, Colombia: Universidad Nacional de Colombia 2006.
26. Markovic V, Bastic L, Characteristics of pumpkin seed oil. J Am Oil Chem Soc 1976; 53(1): 42-44.
27. Agatemor C. Studies of selected physicochemical properties of fluted pumpkin (Telfairia occidentalis Hook F.) seed oil and tropical almond (Terminalia catappia L.) Seed Oil. Pakistan J Nutr 2006; 5(4): 306-307.
28. Neđeral S, Rade D, Škevin D, Štrucelj D, Mokrov□ak Z, Bartolić M. Chemical characteristics of oils from naked and husk seeds of Cucurbita Pepo L. Eur J Lipid Sci Technol 2006; 108(11): 936-943.
29. Ristic-Medic D, Perunicic-Pekovic G, Rasic-Milutinovic Z, Takic M, Popovic T, Arsic A, Glibetic M. Effects of dietary milled seed mixture on fatty acid status and inflammatory markers in patients on Hemodialysis. Sci. World J 2014; ID563576: 9 pages.
30. Patel S, Abdur R. Edible Seeds from Cucurbitaceae Family as Potential Functional Foods: Immense Promises, Few Concerns. Biomed Pharmacother 2017; 91: 330-337.
31. Caili F, Shi H, Li Q. A Review on Pharmacological Activities and Utilization Technologies of Pumpkin. Plant Foods Hum Nutr 2006; 61(2): 70-77.
32. Al-Zuhair H, Amal E, Hekma A. Efficacy of simvastatin and pumpkin seed oil in the management of dietary-induced hypercholesterolemia. Pharmacol Res 1997; 35(5): 403-408.
33. Huang X, Hirose K, Wakai K, Matsuo K, Ito H, Xiang J, Takezaki T, Tajima K. Comparison of lifestyle risk factors by family history for gastric, breast, lung and colorectal cancer. Asian Pac J Cancer Prev 2004; 5: 419-427.
34. Morrison M, Mulder P, Stavro M, Suárez M, Arola-Arnal A, van Duyvenvoorde W, Kooistra T, Wielinga P, Kleemann R. Replacement of dietary saturated fat by PUFA-rich pumpkin seed oil attenuates non-alcoholic fatty liver disease and atherosclerosis development, with additional health effects of virgin over refined oil. PLoS One 2015; 10(9): e0139196.
35. Nishimura M, Ohkawara T, Sato H, Takeda H, Nishihira J. Pumpkin Seed Oil, Extracted From Cucurbita maxima Improves Urinary Disorder in Human Overactive Bladder. J Tradit Complement Med 2014; 4(1): 72-74.
36. Monteiro B. Nutritional value of conventional and unconventional parts of fruits and vegetables. Dissertation, Paulista State University 2009.
37. Burger A, Barros K, dos Santos A, Caixeta P, Damiani, C. Pumpkin peel flour (Cucurbita máxima L.) – Characterization and technological applicability. J Food Nutr Res 2016; 4(5): 327-333.
38. Białek M, Rutkowska J, Adamska A, Bajdalow E. Partial replacement of wheat flour with pumpkin seed flour in muffins offered to children. CyTA - J Food Sci 2015; 14(3): 391-398.
39. Cerqueira P, Freitas M, Pumar M, Santangelo S. The pumpkin (Cucurbita maxima, L.) seed flour effect on the rat glucose and lipid metabolism. Rev Nutr Campinas 2008; 21(2): 129-136.
40. Martínez, A. Efecto del proceso de tostado en el desarrollo de pasta untable de semillas de zapallo (Cucurbita maxima duch). Memoria para optar al título de Ingeniera en Alimentos. Facultad de Ciencias Químicas y Farmacéuticas. Universidad de Chile 2010.
41. Norfezah M, Hardacre A, Brennan C. Comparison of waste pumpkin material and its potential use in extruded snack foods. Food Sci Technol Int 2010; 17(4): 367-373.
42. Biljana B, Rabrenović E, Dimić M, Novaković V, Zorica N, Basić N. The most important bioactive components of cold pressed oil from different pumpkin (Cucurbita pepo L.) seeds. LWT - Food Sci Technol 2014; 55(2): 521-527.
43. Mitra P, Hosahalli S, Kyu R, Chang S. Pumpkin (Cucurbita maxima) seed oil extraction using supercritical carbon dioxide and physicochemical properties of the oil. J Food Eng 2009; 95(1): 208-213.
44. Rosenthal A, Pyle D, Niranjan K. Aqueous and enzymatic processes for edible oil extraction. Enzyme Microb Technol 1996; 19(6): 402-420.
45. Jiao J, Li Z, Gai Q, Li X, Wei F, Fu Y, Ma W. Microwave-assisted aqueous enzymatic extraction of oil from pumpkin seeds and evaluation of its physicochemical properties, fatty acid compositions and antioxidant activities. Food Chem 2014; 147: 17-24.
46. Jing-jing L, Fu Y, Yuan-gang Z, Ji L, Wei W, Cheng-bo G, Meng L. Ultrasound-assisted extraction of flaxseed oil using immobilized enzymes. Bioresour Technol 2011; 102(21): 9991-9996.
47. Gros C, Lanoisellé J, Vorobiev E. Towards an alternative extraction process for linseed oil. Chem Eng Res Des 2003; 81(9): 1059-1065.
48. Jung S, Mahfuz A. Low temperature dry extrusion and high-pressure processing prior to enzyme-assisted aqueous extraction of full fat soybean flakes. Food Chem 2009; 114 (3): 947-954.
49. Wu, Johnson L, Jung S. Demulsification of oil-rich emulsion from enzyme-assisted aqueous extraction of extruded soybean flakes. Biores Technol 2009; 100(2): 527-533.
50. Bahinipati B. The procurement perspectives of fruits and vegetables supply chain planning. Int J Supp Chain Manag 2014; 3(2): 111-131.
51. Fleming C, Speare, D. Creating new markets for vegetables through the production of dehydrated vegetable powders creating new markets for vegetables through the production of dehydrated vegetable powders. USDA 2005; Accessed May 20, 2018. Available at <http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRD3433224>
52. Chan M, Anak S, Gisongb D, Anak B, Rusimd R. Creating new market in integrated agriculture development area in Samarahan, Sarawak, Malaysia – Case study in the supply chain of Cucurbita sp. (Pumpkin). Procedia Soc Behav Sci 2016; 224: 516-522.