Health Benefits of Pumpkin Seed and Nutrition Profile of 35 Pumpkin Accessions[1]

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Introduction

Pumpkin seed (*Cucurbita pepo* L.) is high in oil, protein, and total unsaturated fatty acids (TUFA) and provides an important source of nutrition and income globally. Use of pumpkin seed in the snacking and vegetable oil industry in the US is expected to rise as the market for healthy foods increases. Pumpkin seed is a popular ingredient in snacks sold in retail stores across the country, such as trail mixes with various nuts, seeds, and dried fruit, and is also used as an ingredient in breakfast cereal and bread (Baxter et al. 2012; Loy 2004). In addition, pumpkin seed oil can be purchased by the bottle for use in salads, or as formulated capsules in health food stores (Stevenson et al. 2007). This article will discuss the health benefits, production, processing, and nutritional profile of pumpkin seed.

Currently, most of the pumpkin seed consumed in the US is imported, hence the need to breed high-yielding and nutritious accessions (cultivars) that are locally adapted to various agro-ecological zones in the country. To meet the current and projected demand for pumpkin seed in the US, it is critical for growers to have access to pumpkin cultivars with optimized seed yield, seed size, and seed nutrition. Pumpkin cultivars without seed coat (naked seed) are preferred for snacking and oil production because they eliminate the need for manual de-hulling prior to use. In addition, they are generally higher in oil content than the hulled cultivars. The naked seed trait is conferred by a single recessive mutation that leads to significant reduction in the amounts of lignin and cellulose in the hypodermis, sclerenchyma, and parenchyma tissues of the seed coat (Fruhwirth and Hermetter 2007). Depending on the level of lignification or cellulose in the seed coat, several types of seed phenotypes may form (Figure 1).

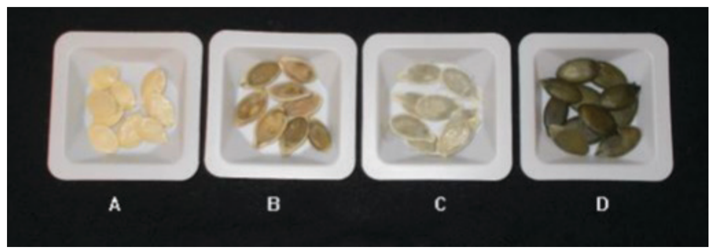

Figure 1. Various *Cucurbita pepo* seed phenotypes, where A) represents hulled seeds, B) represents semi-hulled seeds, C) represents thin layered seeds, and D) represents 'naked' seeds. Credit: Geoffrey Meru

Health Benefits of Pumpkin Seed

Pumpkin seed is a nutritious food with a high oil (50% w/w) and protein (35%) content that varies depending on cultivar (Fruhwirth and Hermetter 2007). Palmitic (≤ 15%), stearic (≤ 8%), oleic (≤ 47%), and linoleic (≤ 61%) fatty acids are the main components of the oil (Bavec et al. 2007), while albumins and globulins make up approximately 60% of the crude protein. The oil content and fatty acid com-position of pumpkin seed is comparable to that of soybean (*Glycine max*) (Panthee et al. 2005), sunflower (*Helianthus*

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annuus) (Baboli and Kordi 2010; Tang et al. 2006), safflower (*Carthamus tinctorius*) (Yermanos et al. 1967), and watermelon (*Citrullus lanatus*) (Jarret and Levy 2012; Meru and McGregor 2014). The high levels of unsaturated fatty acids (oleic and linoleic acids) in pumpkin seed oil provide health benefits that reduce risks of arteriosclerosis and heart-related ailments (Wassom et al. 2008). Pumpkin seed contains significant levels of antioxidants (tocopherols and tocotrienols) that have been associated with a reduced risk of gastric, breast, lung, and colorectal cancer (Lelley et al. 2009; Nesaretnam et al. 2007; Stevenson et al. 2007). Furthermore, phytosterols in pumpkin seed play a key role in lowering cholesterol levels and the treatment of enlarged prostate (benign prostate hyperplasia) (Fruhwirth and Hermetter 2007; Thompson and Grundy 2005).

Production and Processing of Seed Pumpkins

Growers should follow guidelines used in conventional pumpkin production (Bavec et al. 2007). Direct seeding is the most cost-effective system, but it requires seeding equipment and optimum germination conditions. A pneumatic corn seeder can be used for mechanical planting of pumpkin seeds (Bavec et al. 2007). Transplants on raised beds may be used in areas where low temperatures can hamper seed germination. Plant density affects total fruit yield, fruit size, number of fruit per plant, and seed yield (Napier 2009) and is dependent upon the growth habit (vinous, bush, or semi-bush) of the pumpkin cultivar grown. Management of diseases (fungal/fungal-like, bacteria, viruses, and nematodes) should be done conventionally. Harvesting of fruit should be done at maturity to achieve maximum seed oil content (Bavec et al. 2007). Separation of flesh and seed can be achieved manually or mechanically. For oil production, harvested pumpkin seeds should be dried to a 5–7% moisture content and ground. To form soft pulp, water and salt should be added and the pulp roasted for up to 60 min at temperatures around 100°C to allow coagulation of the protein fraction and convenient separation of the lipid fraction by pressing. Pressing should be carried out under isothermal conditions at pressures between 300 and 600 bar. The obtained seed oil should be stored in dark bottles to avoid light-induced deterioration (Fruhwirth and Hermetter 2007). Alternatively, pumpkin seed oil can be extracted through the cold press method, meaning seeds are ground in a screw press at temperatures less than 49°C, causing the oil to be expelled under pressure. Although the latter method produces more pristine oil, extraction efficiency is reduced and some of the oil remains in the seed pulp. After oil extraction, the remnant pressing cake contains a significant level of nutritious components (>60% proteins) and can be used as an animal feed (Fruhwirth and Hermetter 2007; Lelley et al. 2009).

Nutrition Profile of 35 Pumpkin Seed Accessions

Availability of highly nutritious pumpkin seed products is of utmost importance to the consumer. Generally, consumers prefer large-seeded accessions for snacking, but seed size does not matter for consumers of pumpkin seed oil. In addition, pumpkin seed for snacking may be bred for either high protein or high oil value, but for oil production, the latter is a necessity. Pumpkin cultivars can vary greatly in seed oil and protein content, fatty acid composition, and seed size. It is therefore important for consumers/growers to have information on the nutrition profile of pumpkin accessions, so that they can choose those that meet their needs. To generate this information, the Cucurbit Research Program at the University of Florida Tropical Research and Education Center examined key nutrition traits among 35 pumpkin seed accessions. Seed oil and protein content was determined using nuclear magnetic resonance, while fatty acid composition was determined using gas chromatography. Data for the 35 pumpkin seed accessions is presented in Table 1. In general, naked pumpkin accessions were higher in seed oil content and seed size than hulled accessions (Table 2). On the contrary, the reverse was true for seed protein content. Styrian pumpkin and PI 379309 had the highest seed oil content among the naked seed and hulled accessions, respectively. In comparison to major oil crops, the level of healthy fats (unsaturated fatty acids: oleic and linoleic acid) in the current study (78.6%–86.1%) was similar to that of soybean (84.4%) and sunflower (88.6%) (Baboli and Kordi 2010). As mentioned before, unsaturated fatty acids contribute towards reduced risk of arteriosclerosis and heart-related ailments. However, high linoleic acid content in pumpkin seed oil lowers the heat stability of the derived oil, making it unsuitable for cooking. This challenge may be alleviated by developing high-oleic acid, low-linoleic acid pumpkin seed cultivars suitable for production of cooking oil; development of these cultivars will be a focus in our breeding program.

References

Baboli, Z.M., and A. Kordi. 2010. "Characteristics and composition of watermelon seed oil and solvent extraction parameters effects." *J. Amer. Oil Chem*. Soc. 87:667–671.

Bavec, F., S.G. Mlakar, C. Rozman, and M. Bavec. 2007. "Oil pumpkins: Niche for organic producers." In. J. Janick and A. Whipkey (eds.) *Issues in new crops and new uses*. Alexandria, VA: ASHS Press.

Baxter, G.G., K. Murphy, and A. Paech. 2012. The Potential to Produce Pumpkin Seed for Processing in North East Victoria. Rural Industries Development Corporation 11/145: 5–36.

Fruhwirth, G.O., and A. Hermetter. 2007. "Seeds and oil of the Styrian oil pumpkin: Components and biological activities." *Eur. J. Lipid Sci. Technol*. 109:1128–1140.

Jarret, R. and I. Levy. 2012. "Oil and fatty acid contents in seed of *Citrullus lanatus* Schrad." *J. Agr. Food Chem*. 60:5199–5204.

Lelley, T., B. Loy, and M. Murkovic. 2009. "Hull-Less oil seed pumpkin." In J. Vollmann and I. Rajcan (eds.), *Oil Crops, Handbook of Plant Breeding*. DOI 10.1007/978-0-387-77594-4_16.

Loy, J.B. 2004. "Morpho-physiological aspects of productivity and quality in squash and pumpkins (*Cucurbita* spp.)." *Critical Reviews Plant Sci*. 23:337–363.

Meru, G., and C. McGregor. 2014. "Quantitative trait loci and candidate genes associated with fatty acid content of watermelon seed." *J. Amer. Soc. Hort. Sci.* 139:433–441.

Napier, T. (2009) Pumpkin Production. Primefacts for profitable, adaptive and sustainable primary industries. New South Wales Industry and Investment Primefact 964.

Nesaretnam et al. 2007. "Tocotrienol levelsin adipose tissue of benign and malignant breast lumps in patients in Malaysia. Asia. Pac." *J. Clin. Nutr.* 16:498–504.

Panthee, D., V. Pantalone, D. West, A. Saxton, and C. Sams. 2005. "Quantitative trait loci for seed protein and oil concentration, and seed size in soybean." *Crop Sci.* 45:2015–2022.

Stevenson, D.G., F.J. Eller, L. Wang, J.L. Jane, T. Wang, and G.E. Inglett. 2007. "Oil and tocopherol content and composition of pumpkin seed oil in 12 cultivars." *J. Agric. Food Chem.* 55:4005–4013.

Tang, S., A. Leon, W.C. Bridges, and S.J. Knapp. 2006. "Quantitative trait loci for genetically correlated seed traits are tightly linked to branching and pericarp pigment loci in sunflower." *Crop Sci*. 46:721–734.

Thompson, G.R., and S.M. Grundy. 2005. "History and development of plant sterol and stanol esters for cholesterol-lowering purposes." *Am. J. Cardiol*. 96: 3D–9D.

Wassom, J.J., V. Mikkelineni, M.O. Bohn, and T.R. Rocheford. 2008. "QTL for fatty acid composition of maize kernel oil in Illinois High Oil· B73 backcross-derived lines." *Crop Sci*. 48:69–78.

Yermanos, D., S. Hemstreet, and M. Garber. 1967. "Inheritance of quality and quantity of seed-oil in safflower (*Carthamus tinctorius* L.)." *Crop Sci*. 7:417–422.

Table 1. Seed phenotype, seed oil percentage, seed protein percentage, fatty acid composition, and seed size (seed weight, seed length, and seed width) for 35 *Cucurbita pepo* accessions.

Accession	Seed phenotype	Seed oil (%)	Seed protein (%)	Palmitic acid (%)	Stearic acid (%)	Oleic acid (%)	Linoleic acid (%)	10 Seed weight (g)	Seed length (mm)	Seed width (mm)
PI 615086	Hulled	32.96	27.36	10.75	4.87	34.02	48.28	0.71	11.33	7.29
Saffron	Hulled	38.26	31.13	9.51	3.91	31.43	52.68	0.90	12.44	7.83
Sweet Dumpling	Hulled	29.33	31.35	7.80	3.35	23.84	62.00	0.63	11.20	7.61
Bush Delicata	Hulled	33.78	26.39	6.82	4.45	24.65	61.48	0.61	9.94	7.33
Honey Bear	Hulled	37.26	23.11	6.71	5.61	28.14	56.55	1.09	12.71	8.01
Yellow Crookneck	Hulled	39.26	24.42	7.05	4.92	28.74	56.39	0.82	11.73	6.74
Table Queen	Hulled	39.68	21.78	6.91	5.34	34.45	50.44	0.76	11.82	7.25
Early Prolific	Hulled	38.85	23.20	7.98	4.24	39.07	46.16	0.89	11.84	7.63
Black Beauty	Hulled	33.83	23.54	10.70	7.17	38.39	41.13	1.32	14.22	8.36
Baby Bear	Semi-hulled	39.69	28.51	9.07	6.64	24.18	57.49	1.25	14.86	8.84
Triple Treat	Semi-hulled	39.04	26.67	8.87	6.47	39.74	42.83	1.71	15.60	8.14
PI 615102	Semi-hulled	42.83	25.81	10.50	4.59	18.42	64.05	1.16	14.45	8.45
PI 379309	Semi-hulled	48.41	23.74	10.46	6.71	26.50	54.22	1.81	16.17	9.07
PI 364240	Semi-hulled	42.21	28.14	9.42	7.18	40.97	40.49	1.43	16.59	8.55
PI 406679	Semi-hulled	42.37	26.13	10.51	6.36	25.64	55.25	1.60	19.33	9.24
PI 406678	Semi-hulled	45.82	23.94	9.77	5.04	31.51	51.22	1.90	18.47	9.48
PI 267660	Thin layer	43.54	23.75	9.37	4.69	23.25	60.21	1.06	12.20	7.50
PI 267661	Thin layer	44.17	25.88	10.68	6.54	27.19	52.38	1.31	15.98	8.40
PI 267662	Thin layer	44.72	22.77	9.79	5.80	33.95	47.18	1.50	13.77	8.41
PI 267664	Thin layer	47.38	19.59	10.24	5.07	27.08	54.52	1.64	14.17	7.97
PI 420330	Thin layer	45.78	23.27	10.80	4.66	23.02	58.50	1.50	17.40	8.46
PI 420331	Thin layer	43.06	27.10	11.49	5.22	24.01	56.14	1.26	18.05	9.03
PI 506441	Thin layer	45.04	24.78	10.07	4.83	33.72	48.51	1.24	14.50	7.44
Little Greenseed	Thin layer	41.45	28.37	10.11	7.65	31.39	49.15	0.75	12.97	7.24
Yellow Submarine	Thin layer	43.22	21.44	11.48	6.17	28.42	51.43	0.86	15.24	8.03
PI 490278	Thin layer	41.32	26.07	8.53	6.07	42.53	40.19	1.48	16.49	8.16
Beppo	Naked	47.17	22.21	11.64	5.82	21.39	58.83	2.87	18.54	10.38
Styrian	Naked	48.20	24.74	9.88	6.77	25.48	55.90	2.41	18.11	9.21
Lady Godiva	Naked	41.85	21.61	12.64	4.99	35.10	44.01	1.47	16.60	8.52
Slovenska Golica	Naked	45.43	22.99	10.71	6.77	43.53	37.40	2.12	16.72	8.94
Kakai	Naked	44.74	19.48	10.30	5.94	46.09	35.38	1.73	16.51	8.64
PI 615104	Naked	43.30	25.97	11.65	7.24	26.89	51.66	1.67	17.09	9.41
PI 364241	Naked	43.16	21.92	10.90	5.04	37.42	44.25	1.42	15.32	8.17
PI 615133	Naked	44.56	23.22	10.64	4.97	34.41	47.82	2.17	16.68	9.19
PI 311741	Naked	43.02	21.53	10.99	6.08	22.60	57.88	1.84	17.54	8.94

Table 2. Means for seed oil percentage, seed protein percentage, palmitic acid, stearic acid, oleic acid, linoleic acid, and seed size (seed weight, seed length and seed width) among 35 *Cucurbita pepo* accessions with hulled, semi-hulled, thin layer, and 'naked' seed phenotypes. Means within column followed by the same letter are not significantly different ($P < 0.05$).

Seed type	Seed oil (%)	Seed protein (%)	Palmitic acid (%)	Stearic acid (%)	Oleic acid (%)	Linoleic acid (%)	Seed weight (g)	Seed length (mm)	Seed width (mm)
Hulled (n= 9)	35.91^{b}	25.81^{ab}	8.25^{b}	4.87^{a}	31.41^{a}	52.79^{a}	0.86^{c}	11.92^{b}	7.56^{b}
Semi-hulled (n= 7)	42.91^{a}	26.13^{a}	9.80^{a}	6.14^{a}	29.56^{a}	52.22^{a}	1.55^{ab}	16.50^{a}	8.82^{a}
Thin layer (n= 10)	43.97^{a}	24.30^{ab}	10.25^{a}	5.67^{a}	29.45^{a}	51.82^{a}	1.26^{bc}	15.08^{a}	8.06^{b}
Naked (n= 9)	44.60^{a}	22.63^{b}	11.04^{a}	5.96^{a}	32.54^{a}	48.12^{a}	1.97^{a}	17.01^{a}	9.04^{a}