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Kirti Patel

M.Sc. (H.SC), Food and Nutrition, Department of Food and Nutrition, Govt. MH College of Home Science and Science for Women, Autonomous, Jabalpur, Madhya Pradesh, India

Apoorva Soni

Assistant Professor, Department of Food and Nutrition, Govt. MH College of Home Science and Science for Women Autonomous, Jabalpur, Madhya Pradesh, India

Dr. Rajlakshmi Tripathi

Principal, Govt. Lalit Kala Mahavidyalaya, Jabalpur, Madhya Pradesh, India

Pumpkin seed: Nutritional composition, health benefits

Kirti Patel, Apoorva Soni and Dr. Rajlakshmi Tripathi

Abstract

The *Cucurbita sp.* pumpkin seeds from the Cucurbitaceae family, although tiny, pumpkin seeds are incredibly rich in beneficial nutrients and nutraceuticals, including amino acids, phytosterols, unsaturated fatty acids, phenolic compounds, tocopherols, cucurbitacin's, and priceless minerals. A healthy existence and overall well-being depend on all of these bioactive substances. The goal of this review is to integrate the scientific data regarding the possible use of pumpkin seeds as an essential component of food and related biological systems, collected from electronic databases (Science Direct, Research Gate, PubMed, Scopus and Google Scholar) up to January 2020. They could be crucial for the food sectors because they are high in protein, fibers, minerals such as zinc, calcium, magnesium, manganese, cooper and sodium, PUFAs (polyunsaturated fatty acids), phytosterol, and vitamins. These necessary nutrients can be obtained from pumpkin seeds, which can also help with fatigue management, by include them in diet. According to several researches, it has widespread medical applications for antidiabetic, anti-hypertension, anticancer, immunomodulation, antibacterial, anti-hypercholesterolemia, intestinal anti-parasitic, and anti-inflammation (Joachim M, *et al.* 2020) [25]. Additionally, to having pharmacological properties as anti-diabetic, antifungal, antibacterial, anti-inflammation, and antioxidant benefits, pumpkin seeds are a good source of protein.

Keywords: Pumpkin seeds, antidiabetic, antidepressant, anticancer, anthelmintic

Introduction

Due to the significant nutraceutical and therapeutic potential of their bioactive components, pumpkin seeds have drawn increasing attention in recent years. The Cucurbitaceae family includes the vegetable crop known as the pumpkin. It contains such compounds which are rich in vitamin E (tocopherols), Tetracyclic triterpenes, squalene, carotenoids, pyrazine, saponins, triterpenoids, phytosterols, phenolic compounds, unsaturated fatty acid, flavonoids, proteins, fibers, polysaccharides, and minerals such as magnesium, potassium, phosphorus, calcium, sodium, iron, zinc, manganese and copper (Aamir H, *et al.*, 2017, Joachim M. *et al.*, 2020) [44, 25]. The family has the highest proportion of edible plant species of any family in the plant kingdom. Large, non-endospermic, and typically dark red in color, the seeds are encased in a bright yellow fibrous endocarp. It is necessary to supplement staple foods with necessary minerals and vitamins that may not be present in staple diets. Compared to staple foods, they often generate more nutrients per unit of land surface. Oleic and linoleic acids make up the majority of the oil found in pumpkin seed, which is normally an extremely unsaturated oil. Since linolenic acid and other highly unsaturated fatty acids are present in very small amounts, pumpkin seed oil has good oxidative stability for storage or commercial uses and produces few free radicals when consumed by humans. Oleic and linoleic acid distribution patterns are not random, according to studies of pumpkin seed oil triacylglycerol positional isomers (Jakab A *et al.* 2003) [21]. Pumpkinseed oil is ideally suited for enhancing the nutritional value of meals due to its large percentage of unsaturated fatty acid makeup. Numerous health advantages have been attributed to pumpkin seed oil (Tsai YS, *et al.* 2002) [42]. Preventing prostate growth and shrinking its size is the most important health advantage associated with pumpkin seed oil (Gossell-Williams M, *et al.* 2006) [16]. Additionally, there is evidence to support the claims that pumpkin seed oil helps prevent the development of hypertension, reduce hypercholesterolemia, and treat arthritis (Fu C, *et al.* 2006) [15].

The lipid components of pumpkin seeds have been associated with decreased bladder and urethral pressure and enhanced bladder compliance. It has been discovered that pumpkin seed oil reduces diabetes by encouraging hypoglycemic activity.

Corresponding Author:

Kirti Patel

M.Sc. (H.SC), Food and Nutrition, Department of Food and Nutrition, Govt. MH College of Home Science and Science for Women, Autonomous, Jabalpur, Madhya Pradesh, India

In the diets of the Japanese, pumpkin seed oil has been proven to be a considerable source of vitamin E (Tocopherol). Additionally, pumpkin seed-rich diets have been linked to decreased rates of gastric, breast, lung, and colorectal cancer. The numerous carotenoid pigments included in pumpkin seed oil may also have health benefits, and carotenoids from all sources of pumpkin fruit have been associated with the protection of prostate cancer (Aamir H, *et al.* 2017) [44].

Although pumpkin seed oil provides the previously mentioned health advantages, research has demonstrated that it has no antimicrobial properties. Murkovic *et al.* (2003) [31] claimed that roasting seeds results in an improvement in their nutritional content. Basically, roasting raises the sterol and vitamin E concentrations. Tocopherols' potent antioxidant abilities may have a big impact. The amount of α - and γ - Tocopherol in roasted pumpkin seed oil was found to be higher than that in roasted sunflower seed oil. A total of 20.1 mg/100 g of Tocopherol was present, with 87% of it being in the γ -form and no β - or δ - Tocopherol being found. The last few decades have seen a focus on pumpkin due to its widespread medicinal uses (Jakovljevic LJ, *et al.* 1995) [22]. Using modern tools, researchers have given pumpkin credit for having antidiabetic, antihypertensive, antitumor, antibacterial, anti-hypercholesterolemia, intestinal anti-

parasitic, anti-inflammatory, and analgesic properties.

Recent research on the activity and make-up of dietary fiber fractions derived from pumpkin has revealed their potential for application as food additives or as ingredients in foods to enhance food quality. Pumpkin is a low-cost, high-yielding food that is very simple to raise (Aamir H, *et al.* 2017) [44].

Nutritive value of pumpkin seed

Pumpkin seeds are incredibly rich in useful, functional nutrients. While the primary metabolites that maintain life are found in pumpkin seeds' nutrition, functional components of the seeds also play important roles in human illness prevention and health enhancement.

Researchers evaluated the physical characteristics, chemical content, and ratio of fatty acids in pumpkin seeds. They discovered that the seeds contained 41.59% oil, 25.4% protein, 5.2% Moisture, 25.19% carbohydrates, 5.34% fiber and 2.49% total ash. According to Ardabili, total phenolic compounds, total sterols, total waxes, and total tocopherols were, respectively, 66.25 (mg galic acid per kg oil), 1.86%, 1.56%, and 882.65 (mg tocopherol per kg oil), (Qamar A. *et al.* 2019) [45].

A thorough examination of the bioactive profile and nutritional composition of pumpkin seeds is shown below: -

Table 1: Nutritional composition of pumpkin peel, fruit, seed (Batoool M, *et al.* 2022) [8]

Nutrient	Pumpkin Peel (Value/100 g)	Pumpkin Fruit (Value/100 g)	Pumpkin seed (Value/32.25 g)
Energy	520.78 kg	109 kg	NR
Water	89.527 mg	91.6 g	1.69 g
Lipids	1.650 mg	0.1 g	15.82g
Protein	14.670 mg	1.0 g	9.75 g
Ash	7.317mg	0.8 g	1.54 g
Dietary fiber	13.383 mg	0.5 g	1.94 g
Carbohydrates	12.407 mg	6.5 g	3.45 g
Total sugars	7.633 mg	2.76 g	NR
Calories	NR	26 kcal	180.28 kcal
Carotene, beta	NR	3100 μ g	NR
Carotene, alpha	NR	4016 μ g	NR
Reference	Amin <i>et al.</i> (2019) [4]	USDA (2022) [43]	Mateljan <i>et al.</i> (2022) [30]

NR: Not Reported

Table 2: Mineral Composition of pumpkin peel, fruit and seed (Batoool M. *et al.*, 2022) [8]

Nutrient	Pumpkin Peel (mg/100 g)	Pumpkin Fruit (mg/100 g)	Pumpkin seed (mg/32.25 g)
Calcium	1.360	21	14.84
Iron	4.004	0.8	2.84
Magnesium	3.353	12	190.92
Phosphorous	1.419	44	397.64
Potassium	687.467	340	260.90
Sodium	9.652	1.0	2.26
Zinc	0.150	0.32	2.52
Copper	0.025	0.127	0.43
Manganese	0.360	0.125	1.47
Selenium	NR	0.3 μ g	NR
Reference	Amin <i>et al.</i> (2019) [4]	USDA (2022) [43]	Mateljan <i>et al.</i> (2022) [30]

NR: Not Reported

Table 3: Vitamin composition of pumpkin fruit and seed (Batoool M. *et al.*, 2022) [8]

Nutrient	Pumpkin Peel (mg/100 g)	Pumpkin Fruit (mg/100 g)	Pumpkin seed (mg/32.25 g)
Vitamin A	0.426	0.019	0.0015
Vitamin C	9.0	0.3	0.61
VitaminB1	0.05	0.034	0.09
Vitamin B2	0.11	0.052	0.05
Vitamin B3	0.6	0.286	1.61
Vitamin B5	0.298	0.056	0.24
Vitamin B6	0.061	0.037	0.05
Vitamin B9	0.016	0.009	0.0187
Vitamin E	1.06	NR	0.70
Vitamin K	0.001	NR	0.0023
Reference	Amin <i>et al.</i> (2019) [4]	USDA (2022) [43]	Mateljan <i>et al.</i> (2022) [30]

NR: Not Reported

Therapeutic Importance

Numerous studies have demonstrated the beneficial effects of pumpkin and its components, including its seeds, pulp, and extractions of its bioactive components, on human health and well-being.

Hypertensive and Heart Protective Effects

Consuming pumpkin may lower blood pressure by blocking the angiotensin-1 converting enzyme, which is linked to blood vessel constriction. Pumpkin's phytosterols, mixed tocopherols, carotenoids, and essential fatty acids can help lower cholesterol and decrease oxidative stress and inflammation. In the small intestine, phytosterols prevent cholesterol from being absorbed. Of the popular nuts and seeds, pumpkin seeds have the third-highest phytosterol concentration. Pumpkin seeds typically include four main fatty acids: Stearic (8%), Palmitic (13.3%), Oleic (29%), and Linoleic (47%). According to studies, oleic acid can protect atherosclerosis by either altering the generation of nitric oxide or by preventing the expression of adhesion molecules. Because of their ability to scavenge peroxy radicals and possess antioxidant properties, tocopherols protect the cardiovascular system. Mortality from cardiovascular disease is inversely correlated with consuming foods high in tocopherols. Due to their abundance in unsaturated fatty acids, particularly-linoleic acid (Behrooz *et al.*, 2013) ^[9], pumpkin seeds have been shown to have antiatherogenic properties (Barakat and Mahmoud, 2011) ^[7]. According to Neferti.com, pumpkin seed oil makes blood vessel walls more elastic and sturdier, which aids in the treatment of atherosclerosis. Plant sterols and stools found in pumpkin seeds have been linked to atherosclerosis prevention (Palande, 2010) ^[35]. Pumpkin's high fiber content also aids in reducing the risk of atherosclerosis (Levin, 2012) ^[29]. Pumpkin seeds are beneficial for preventing atherosclerosis due to their high vitamin K content (Tawheed A *et al.*, 2013) ^[41].

Numerous studies have been done on the *Cucurbitaceae* species, which is a component of the Mediterranean diet, to comprehend its association with CVD. Unsaturated fats have been shown to reduce the risk of numerous heart diseases, whereas saturated fats increase the risk. In light of these findings, a study was undertaken in which a diet rich in mono and polyunsaturated fatty acids boosted HDL levels while lowering LDL levels. Following this information, another study was carried out in 2011 to compare the effects of pumpkin oil and olive oil on blood lipoprotein levels. This was done because both oils have high PUFA and MUFA contents. Both olive and pumpkin oil changed the serum lipid profile. Olive oil, however, had a much greater impact than pumpkin seed oil. As a result, this supports the use of pumpkin seed oil in the treatment of heart issues and allows for further investigation of the oil. The endothelium layer becomes dysfunctional when the body has high cholesterol levels, which increases the levels, which increases the level of the vascular cell adhesion molecule (VCAM), (Batoool M, *et al.*, 2022) ^[8].

Antidiabetic effects

One of the diseases that affects older adults the most frequently is diabetes mellitus. Diabetes mellitus is a metabolic condition in which the body either does not create enough insulin or does not adequately respond to it. The two primary kinds of diabetes are type I and type II. Severe effects from chronic hyperglycemia include damage to the kidneys (nephropathy), brain (neuropathy) and eyes (retinopathy). By

2030, there may be 82 million people globally who will have diabetes, according to a remarkable global expansion of the disease. Due to the fact that these regions account for more than 80% of all deaths related to diabetes, people in low-income and middle-class countries are affected by DM (Batoool M. *et al.*, 2022) ^[8].

Herbal preparations, which frequently contain pumpkin, are used to treat hyperglycemia in Mexico and China (Andrade-Cetto A, *et al.* 2005) ^[46]. In-depth research has recently been done to examine the anti-diabetic properties of pumpkin flesh, seeds, and peel (Rolnik, A *et al.*, 2020) ^[37]. According to this study, pumpkin powder tends to increase the body's production of insulin, which lowers glucose levels. As a result, it also reduces the possibility of renal damage (Ahmad G *et al.*, 2019, Chen JG *et al.*, 2005) ^[3, 12]. Complex carbohydrates are typically broken down in the small intestine by the enzyme α -glycosidase, which is found in epithelial mucosa. The breaking of glycosidic linkages found in complex carbohydrates by the enzyme α -glycosidase rise blood glucose levels. It is frequently emphasized that using pumpkin can reduce α -glycosidase activity (Jaiswal N, *et al.*, 2012) ^[20].

Treatment of functional disorders of bladder

For many years, people have relied on pumpkin seed oil to treat problems connected to an enlarged prostate gland and micturition issues related to an irritated bladder. The therapeutic effect of pumpkin seeds on the relaxation of the sphincter and bladder is what leads to their use in treatment. According to studies (Stevenson *et al.*, 2007) ^[40], lipid elements in pumpkin seeds oil have been shown to lower bladder and urethral pressure and enhance bladder compliance. According to Ardabili *et al.* (2011) ^[6], minor problems of the prostate gland and urinary bladder brought on by hyperplasia (BHP) are also treated with pumpkin seed oil. The non-cancerous growth of the prostate gland known as benign prostatic hyperplasia (BPH) is brought on by the proliferation of both stromal and epithelial cells. After the age of 40, benign prostatic hyperplasia appears and has a high rate of morbidity but a low risk of mortality. Numerous chronic and serious disorders have been treated with herbal remedies (Dordevic M, *et al.* 2016) ^[47]. Pumpkin seeds have been shown to have ameliorative effects on testosterone- and citral-induced prostate hyperplasia in Wistar male mice and rats, respectively (M.K. Abdel *et al.* 2006) ^[2].

Arthritis and Bone protective Effects

Zinc-rich meals made from pumpkin seeds are also utilized to prevent bone fractures (Tawheed A, *et al.* 2016) ^[48]. For those at risk of osteoporosis, zinc supports bone density and strengthens the immune system. For postmenopausal women in particular, pumpkin is beneficial to eat. According to Jeznach *et al.* (2012) ^[23], the γ -tocopherol and beta-carotene found in pumpkin seeds have anti-inflammatory characteristics and can be utilized to treat arthritis and other illnesses that produce uncomfortable swelling. According to several research (Biesiada *et al.*, 2009; Cool, Yahoo! Health, 2013) ^[10], pumpkin seeds offer more healing and anti-inflammatory effects than pharmaceutical medications. Consumption of pumpkin seeds fared quite well in a comparative test between indomethacin, a typical arthritis medication, and the former. In fact, compared to indomethacin, pumpkin seeds had a better effect on the breakdown of the lipids in the joint linings. Pumpkin seeds have been shown to naturally alleviate arthritis-related

inflammation. They do not raise the level of harmful fat in the linings of the joints (Tawheed Z *et al.* 2016)^[48].

Anthelmintic effect

Pumpkin seeds have been utilized in traditional medicine in North America and Mexico as an anthelmintic and supportive treatment for functional bladder diseases (EI-Aziz and EI-Kalek, 2011)^[14]. An immune-compromised person is more prone to parasitic infections, which are commonly correlated with an increase in harmful bacteria and a decline in the population of beneficial bacteria like *Lactobacillus acidophilus*. The removal of parasite infection is aided by the combination of pumpkin seeds, papaya extract, flaxseeds, beet root, citrus pectin, and psyllium husks (Ibrahim, 2011)^[19]. Pumpkin seeds contain a substance called cucurbitin, which has anti-parasitic properties (Ibrahim, 2011)^[19]. A study by Tawheed Z, *et al.* (2016)^[48] found that a minimum inhibitory concentration (MIC) of 23 grams of pumpkin seeds in 100 milliliters of distilled water can have an anthelmintic effect. MIC of 23 g of pumpkin seed in 100 ml of distilled water was discovered to have an anthelmintic effect in pre-clinical tests. When combined with papaya seeds, pumpkin seeds are also highly efficient in the lower intestines and increase that of the former.

Anticarcinogenic effect

By eating the right foods and using dietary supplements, cancer can be prevented. In addition, only 5 to 10% of cancers are hereditary, with the majority being caused by a person's lifestyle. Several studies have looked into the anti-cancerous potential of pumpkin. According to reports, eating pumpkin seeds reduces your risk of developing some cancers include breast, rectal and lung cancer (Batool M. *et al.*, 2022)^[8].

Pumpkin is employed as an anticancer agent in the majority of nations (Caili and Quanhong, 2006)^[11]. Muscatine, a brand-new ribosome-inactivating protein, has been isolated from pumpkin seeds. Muscatine has been utilized to create an immunotoxin that can effectively and selectively kill cultured human melanoma cells because it has a high inhibitory function on protein synthesis (Chuan *et al.*, 2004)^[13]. According to the findings, Muscatine may be an innovative potential anticancer agent (Owini, 2006)^[34]. According to several studies (Lenard, 2009)^[28], pumpkin seeds contain lignans that have been shown to have anticancer characteristics, including those for malignancies of the breast, endometrial, colon, and prostate. Pumpkin seeds' anticancer properties are attributed to the presence of these lignans, which only become anticancer after being consumed and transformed into mammalian lignans by intestinal bacteria, particularly enterolactone and enterodiol (Tawheed Z *et al.* 2016)^[48]. Lignans and is flavones, which are phytoestrogens, are abundant in pumpkin seeds. In the female body, phytoestrogen frequently binds with estrogen receptors (ER). A study was done to look at the relationship between pumpkin seed extract, which contains phytoestrogens, and breast cancer. Estradiol synthesis was found to have increased in MCF7, BeWo, and Jeg3 cells, and ER levels to have decreased in MCF7 cells. In essence, a study has found that 2S albumins, which are proteins found in pumpkin seeds, have anti-cancerous capabilities, notably in the case of breast cancer. Protein was applied to MCF7-cells at two distinct from DNA tests and acridine orange staining demonstrated that 2S albumins from pumpkin seeds have a propensity to induce apoptosis in MCF7-cell lines (Batool M, *et al.*, 2022)^[8].

Antidepressant effect

Depression is a frequent disorder that causes periods of repressed psychosocial functioning, reduces quality of life, and manifests as symptoms such interrupted sleep and hunger, poor attention, excessive guilt, and occasionally suicidal thoughts. According to reports, more than 4 million people suffered from depression-related issues in 2001. In 2008, depression was classified as the third leading cause of sickness worldwide; however, by 2030, it is anticipated to overtake all other causes. Depression would cost countless lives if urgent and effective action was not taken. Antidepressant chemicals have reportedly been found in several plants (N. Eloziia, *et al.*, 2017)^[33]. Pumpkin seeds scored 47% on the antidepressant food score (AFS) chart recently published by LaChance and Ramsey, (2018)^[27], who profiled the antidepressant foods. This indicates that pumpkin seeds have the potential to be an antidepressant. Another study investigated the effectiveness of pumpkin seed extracts (PSE) and the conventional medication imipramine in rats using forced-swimming and tail-suspension tests. According to the study's findings, pumpkin seeds have strong antidepressant properties (S. George *et al.*, 2012)^[38]. Despite the fact that the exact mechanism of action of PSE is still unknown, JR Hibbeln, (1998)^[17] and G.A Eby *et al.* (2006)^[16] connected the antidepressant effect to tryptophan, an essential amino acid, and 5-hydroxytryptophan, a tryptophan intermediate metabolite that is used to create the neurotransmitter serotonin. Additionally, studies concentrating on animal and clinical trials are required to disclose and confirm the pumpkin seed's beneficial effects on depression. Information on the potential of pumpkin seed is scarce in this region.

Antimicrobial effect

The primary causes of many people's deaths are bacteria, parasites, viruses, and fungus, which produce various diseases and cause death in spite of a clean atmosphere and hygienic diet. The antibacterial components that have been identified from pumpkin seed oil are present in the oil from pumpkin seeds (Qamar A *et al.*, 2019)^[45]. According to Hammer *et al.* (1999)^[26], the growth of *Aeromonas veronii*, *Candida albicans*, *Enterococcus faecalis*, *Escherichia coli*, *Salmonella enterica*, *Typhimurium*, and *Staphylococcus aureus* is inhibited by pumpkin seed oil at a concentration of 2%. It had been investigated how to inhibit the growth of the yeast cell using the basic proteins of pumpkin seeds, MAP2, MAP11, and MAP4. The MAP11 basic protein exhibited the highest levels of inhibitory effects compared to other proteins. *Escherichia coli*, a G-ve (gram negative) bacterium, did not experience any growth inhibition from the MAP2 or MAP4 Cheong *et al.* (1997)^[32]. Additionally, phloem exudates from pumpkin seeds have been said to have anti-fungal effects and to suppress the pathogenic fungus (Xie JM *et al.* 2004)^[24]. The novel protein, pr-1 protein, which has anti-fungal capability without being hazardous to human erythrocytes (RBCs), was identified by Park and his colleagues from pumpkin seeds (Qamar A *et al.*, 2019)^[45].

Liver Disease Preventive Properties

The liver-protective properties of pumpkin have been documented by a number of researchers in the past. In order to cause liver failure, a low-protein diet was given to male Sprague Dawley rats for five days in a 2005 study. Following CCl4 injections, their levels of the four liver enzymes aspartate transaminase (AST), alkaline phosphatase (ALP),

alanine transaminase (ALT), and lactate dehydrogenase (LD) were all noticeably elevated. The level of both of the aforementioned enzymes was reduced in one group after receiving a dose of pumpkin seed protein isolate, indicating the usefulness of pumpkin in the treatment of liver dysregulation. The similar hepatoprotective effect of pumpkin seeds protein isolate was primarily found through improving antioxidant activity and reducing liver enzymes in another investigation conducted on rats with CCl₄. The same finding was also found by another study that was carried out to comprehend the impact of fluted pumpkin leaf extract on anemia. In this instance, the aqueous leaf extract of pumpkin at 50mg/kg has the propensity to control ALT and AST. All of these studies lend credence to the notion that pumpkin seed protein isolates have a propensity to reduce the high levels of liver enzymes (ALT, AST, ALP, LD) when liver damage is brought on by a low-protein diet or malnutrition. The same changes in these liver enzymes caused by pumpkin usage were reported by (Batoool M. *et al.* 2022)^[8].

Atherosclerosis is a major health problem that causes mortality and morbidity worldwide and is further caused by non-alcoholic fatty liver disease (NAFLD). Intake of fats and the kind of fat present in a person's diet play a crucial role in both treating NAFLD and preventing its occurrence. Unsaturated fatty acids make up around 80% of enriched phytochemicals, as was already established, and pumpkin seed oil is abundant in them (Batoool M. *et al.* 2022)^[8].

Conclusion

The seeds, skins and peel of pumpkins are excellent providers of micro and macronutrients such fiber, amino acids, MUFA, PUFA, Tocopherol and carotenoids. In functional foods and pharmaceutical goods, pumpkin may be used as an ingredient of choice due to the availability of different bioactive phytochemical components that have shown health-promising effects. According to earlier research, pumpkins play a vital role in the prevention and treatment of diabetes, cancer, liver illnesses, cardiovascular diseases, and depression. Researchers have also noted the usage of *cucurbit species* as sources of antioxidant, antibacterial, anti-inflammatory, and anti-ulcerative activities.

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