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# NUTRITIONAL AND THERAPEUTIC POTENTIAL OF BIOACTIVE COMPOUNDS FROM MELONS: A MINI REVIEW

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**ABSTRACT**

Fruit wastes are one of the major sources of municipal waste, however they are a source of bioactive useful compounds which possess numerous health benefits. The fruit processing industry generates 10-60% waste or by-products in solid (peel, seed) and liquid (fruit juice) waste. Melon is a prevalent fruit, consumed worldwide, containing significant quantities of by-products (seed, peel, rind) that have been discarded. Melon is an excellent source of biologically active compounds for humans due to its good taste and rich chemical composition. Various bioactive compounds present in fruit waste (seed and rind) of melon is responsible for its numerous biological activities such as anti-inflammatory, antioxidant, anti-diabetic, anti-carcinogenic, and anti-microbial activity.

**Keywords:** Melons, bioactive compounds, nutritional potential, therapeutic potential, antioxidants, phytochemicals, anti-inflammatory properties, melon polyphenols, functional foods

## INTRODUCTION

Natural sources are widely being investigated for their beneficial role in preventing, delaying and ameliorating a variety of disorders (**Vinod *et al.*, 2022**, **Kuriakose A et al., 2022**; **Varsha *et al.*, 2022**). Although fruit wastes are one of the major sources of municipal waste, they have bioactive useful compounds which possess numerous health benefits **(Rahmah *et al.*, 2022; Sarkar *et al.*, 2022; Adetunji *et al.*, 2023; Zainul *et al.*, 2024).** Melon is one of the world's most widely cultivated fruits. It is a popular fruit in Brazil and is commonly consumed in Europe, the United States, and Japan. Melon belongs to the Cucurbitaceae family and is a part of the Cucumis genus (Silva et al., 2012). Fresh melons are used in salads, prepared soup, curry, and pickles. Mature fruit is consumed as a dessert fruit, canned, or utilized in syrups (**McCreight *et al.*, 1993).** Melons typically contain over 90% water, have low fat content, and are a rich source of vitamins, dietary fibre, and carbohydrates. Melon is a good source of biologically active compounds for humans due to its pleasant taste and rich chemical composition. Melon contains glucose, fructose, vitamin A, D, E, K, and C. The flesh contains phenolic compounds and flavonoids. Melon peel's high fibre, pectin, phenolic, and flavonoid content makes it more suitable for use in dietary supplements and as a cosmetic product (**Castillo *et al.*, 2014**). Biological activities reported for melon include anti-oxidative, anti-inflammatory, analgesic, anti-ulcer, anti-hyperlipidaemic and anti-diabetic, along with inhibition of proliferation of specific cancer cell (**Jaiswal, 2020**). This review is mainly focused on the therapeutic applications of commonly consumed melons: Watermelon (Citrus lanatus), Musk melon (Cucumis melo), and Bitter melon (Momordica Charantia) (Table 1). Watermelon contains lycopene, vitamin A, and vitamin C, which are responsible for antioxidant, anti-diabetic, and anti-inflammatory activity (**Nkoana *et al.*, 2022**). The different types of polyphenols in Musk melon contribute to its anticancer activity (**Rolim *et al.*, 2020**). The medicinal uses of Momordica charantia (M. charantia) are due to the presence of bioactive compounds such as flavonoids, polyphenols, proteins, saponins, and triterpenoids. It also contains polypeptide, charatin, vicine and ribosome-inactivating proteins (RIPs), which contribute to its anti-diabetic activity (**Li *et al.*, 2020**).

**Table 1** Bioactive compounds of Melons with their biological activity

| Types of melons | Bioactive compounds | Biological activity | References |
|---|---|---|---|
| *Momordica charantia* | polysaccharides, peptides and proteins, phenolics | anti-diabetic, anti-oxidant, anti-tumour, anti-microbial | (**Li *et al.*, 2020**) |
| *Citrus lanatus* | carbohydrates, vitamins, minerals, phenolics, carotenoids | anti-inflammatory, anti-microbial, anti-diabetic | (**Nkoana *et al.*, 2020**) |
| *Cucumis melo* | flavonoids, phenolics, carotenoids, hydrolyzable tannins | antioxidant, anti-cancer, antiulcer, antidiabetic | (**Rolim *et al.*, 2020**) |

**Chemical composition**

***Flavonoids and Phenolic compounds***

Flavonoids and phenolic compounds are essential constituents present in melons. They include gallic acid, gentisic acid, protocatechuic acid, vanillic acid, p-coumaric acid, benzoic acid, o-coumaric acid, chlorogenic acid, ferulic acid, catechin and epicatechin. In bitter melon, catechin is the most abundant phenolic acid (**Tan *et al*., 2014**). Peels and seeds are potential sources of flavonoids and polyphenols. As per Budget et al., catechin is the phenolic acid present in bitter melon with the maximum percentage, followed by gentisic acid, chlorogenic acid, and gallic acid. Melon peel is rich in the phenolic compound luteolin, chlorogenic acid, apigenin, hydroxycinnamic acid, flavones, flavanone, and hydroxybenzoic acid (**Budrat & Shotipruk, 2009**). Cantaloupe contains a variety of polyphenols, such as flavonoids, phenolics, and hydrolysable tannins, which have anticancer and anti-proliferative activity. The phenolic compound 3-hydroxy benzoic acid in honeydew has anti-fungal, anti-mutagenic, and anti-diabetic properties (**Mallek-Ayadi *et al*., 2017**). The flesh of bitter melon contains the primary phenolic acid, gallic acid, gentisic acid, catechin, and epicatechin (**Horax *et al*., 2005**).

**Saponins and Terpenoids**

Saponins belong to the class of glycosides and are found in the root, stems, leaves, and fruits of melons. The steroidal saponin and the triterpenoid saponin (cucurbitacin alkyl type, oleanane type, and ursane type) are widely distributed in melon plants. Cucurbitane is responsible for anti-diabetic activity in bitter melon (**Jia *et al*., 2017**). The two types of musk melon, Cantaloupe (C. melo.L) and Honeydew (C.melo.var) are good sources of β-carotene (**Lester, 1997**). Cantaloupe melon accumulates up to 60-fold more β-carotene than honeydew melon. The melon peel contains the highest amount of β-carotene. Carotenoids, especially lycopene, can reduce the risk of various human cancers (colon, breast, prostate), cardiovascular diseases, and nervous system disorders (**Sabino *et al*., 2015**).

**Fatty Acid**

Melon seed oil contains biologically active substances like tocopherol, phospholipid, and sterols which has a beneficial effect on humans (**Azhari *et al*., 2014**). The primary components of melon seed oil are stearic acid, palmitic, oleic and linoleic, and stearic acid. The antioxidant action of the melon seed oil is due to the presence of phytosterols of melons (**Morais *et al*., 2017**). The percentage of unsaturated fatty acid is more significant in the melon peel. The primary fatty acids in the melon peel are palmitic, linolenic, and myristic acid. Palmitic acid and omega 6-linolenic acid is the most abundant fatty acid in the melon rind (**Panda *et al*., 2015**). Bitter melon possesses a high level of fatty acids.

**Polysaccharides**

Polysaccharides are critical bioactive components present in melons and are associated with antioxidant, anti-diabetic, anti-tumour, immune enhancing, neuroprotective, and anti-microbial effects (**Jia *et al*., 2017**). Watermelon rind (WMR) contains glucose, galactose, xylose, arabinose and rhamnose, and are responsible for antioxidant, anti-tumour, anti-viral and anti-coagulant activity (**Dammak *et al*., 2019**). Fructose, glucose, mannose, arabinose, and xylose are present in melon seeds. The melon rind contains polysaccharides such as hemicellulose, cellulose, lignin, and pectin (**Zia *et al*., 2021**). Sugar compositions in cucurbits fruit include sucrose, fructose, and glucose. Cantaloupe melon contains 55% sucrose, 19% glucose, and 24% fructose, with a small number of other carbohydrates. Honeydew also has a high concentration of monosaccharide (33% glucose and 36% fructose (**Raman et al., 1996**).

**Proteins and peptides**

Proteins and peptides are the main functional components present in the fruit and seed of melons, particularly, ribosome-inactivating protein (RIP). RIP possess N-glycosidase activity, DNase (deoxyribonuclease) activity, anti-tumor and phospholipase activity, anticancer, immunosuppressive, and anti-microbial activity. Melons are also rich in amino acids, especially L-citrulline (**Fang *et al*., 2012**). The proteins are found to induce apoptosis in glioblastoma, prostate, breast, lung, and hepatocellular carcinoma cells (**Abudayeh *et al*., 2016**). The melon seed has a high percentage of protein (20-27%). The primary amino acids in the melon seed are glutamic acid, aspartic acid, arginine, and cysteine. The essential amino acids, methionine and lysine are found in low concentration in melon seeds (**Zhang *et al*., 2015**). Citrulline, a non-essential amino acid in melon rind, can help fight free radicle damage and boost the immune system. Citrulline has also potential antioxidant and vasodilatatory roles (**Yuwai *et al*., 1991**).

**Other Components**

Unsaturated fatty acids, alkaloids, amino acids, minerals, and vitamins are also present in melons (**Enemor *et al*., 2019**). Melons are a good source of dietary fibre, potassium, copper, and an excellent source of Vitamin C and B6. Melon seeds are a good source of proteins, vitamins (thiamine, niacin, vitamin B6, folate, and pantothenic acid) and minerals (magnesium, copper, zinc, iron, potassium, phosphorus, and manganese (**Gladvin *et al*., 2017**). The melon rind is full of Vitamin C, B6, and A. It is also rich in fibre. Fiber aids in ensuring regular bowel movements and may help lower the chance of developing colon diseases.Vitamin C, an essential element for bone growth, wound healing, and disease prevention, is abundant in bitter melon. It also contains vitamin A, which supports healthy skin and good vision (**Raman *et al*., 1996**). Musk melon is rich in vitamin C and folate, which prevent disease and strengthens immune function (**Qian *et al*., 2019**). Honeydew (C. Melo. L) is rich in water and electrolytes, such as potassium, magnesium, sodium, and calcium (**Saltveit, 2011**).

**Table 2** Effects of melon fruit wastes in animal models

| Activity | Melon | Species | Part | Extract/ Fraction | Active constituent | Dose | Animal model | Findings | References |
|---|---|---|---|---|---|---|---|---|---|
| Anti-diabetic | | | | | | | | | |
| | Water melon | *Citrullus lanatus..var* | Rind | Juice | Lycopene | 1ml of rind juice given daily/animal by orogastric tube | Streptozotocin-induced diabetic female albino rats | Ameliorated structural changes in the pancreas | (**Sorour *et al*., 2019**). |
| | Musk melon | *Cucumis melo.var.agrestis (CMA)* | Leaves | Hydroalcoholic leaf (HALEC) extract of CMA leaves | Gallic acid, quercetin rutin | Oral administration of HALEC (300 and 600mg/kg) | STZ-NIC induced diabetic rats | Decrease in blood glucose level | (**Gopalasatheeskumar *et al*., 2020**). |
| Antioxidant activity | Watermelon | *Citrullus lanatus* | Seed protein | Globulin | Lycopene | 1g/kg BW for 15 days | Ethanol-induced oxidative stressed rats | Maintain normal cellular function and prevent oxidative stress | (**Tripathi and Chandra, 2010**). |
| | Bitter melon | *M.charantia* | Pulp/fruit | Aqueous | Charatin, vivine | 13.33g pulp/BW by oral gavage | Alloxan-induced diabetic rats | Antioxidant potential to protect the vital organ from diabetic-induced oxidative stress | (**Dash *et al*., 2020**). |
| Antihypertensive activity | Water melon | *Citrullus lanatus* | Seed | Dried watermelon seed | Phytochemicals (alkaloids, polyphenol cations ($K^+$, $Mg^{2+}$) | 50g daily for 40 days | male and female rat | Decrease in systolic and diastolic pressure | (**Sajjad *et al*., 2020**). |
| Nephroprotective | Water melon | *Citrullus lanatus* | Seed | Aqueous | Carbohydrates, minerals, vitamins | 600mg/kg BW aqueous extract of water melon seed (WMS) | Alloxan-induced diabetic Wistar rats. | Increase in liver enzyme activities, increase in electrolyte concentration | (**Zhang *et al*., 2015**). |
| | | *Citrullus lanatus* | seed | Aqueous and Methanolic | Lycopene | 200mg/kg and 400, g/kg BW for 28 days | Acetaminophen-induced female albino rats | Nephroprotective | (**Omotoso and Osadiaye, 2018**). |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Neuro-protective | Water melon | *Citrullus lanatus* | seed | Ethanolic extract | Proteins | 76mg/kg oral median dose | Wistar rats | Increase Cognitive function | (**Finbarrs *et al*., 2018**). |
| Cardioprotective/anti-hyperlipidaemic | Bitter melon | *M.charantia* | powder | Freeze-dried powder | Charatin, vivine | Freeze-dried powder 0.5,1 and 3% and bitter melon 1% | Rats fed supplemented with or without cholesterol. | Reduction in hepatic cholesterol level and triglycerides level in the presence and absence of cholesterol | (**Jayasooriya *et al*., 2000**). |
| | Water melon | *Citrullus lanatus* | Seed | juice | lycopene | 120g/70kg body weight as standard, juice orally administered for two weeks | Normal experimental rats | Decrease level of triglycerides, serum creatine, kinase, and sodium | (**Ibrahim et al., 2018**). |
| Anticancer ctivity | Bitter melon | *M.charantia* | leaves | Crude extract | Lectin | *Eight* µg protein, bi-weekly, intraperitoneally | Mice induced with tumors | Inhibited tumor formation | (**Jilka *et al*., 1983**). |
| | Musk melon | *C.melo.var* | pedicel | Cucurbitacin extract | Cucurbitacin -B | 0.75mg/kg, diluted with saline, intraperitoneally injected | NSCLC (non-small cell lung cancer) mice model | Promising therapeutic agent for NSCLC | (**Yuan *et al*., 2021**). |
| | Waterm elon | *Citrullus lanatus* | pulp | Watermelon pulp juice | Lycopene, carotene, Xanthophyll | 500mg/kg BW by oral gavage | Mice with induced melanoma | Alternative for reducing the side effects of anti-neoplastic agents | (**Cruz *et al*., 2022**). |
| Anti-inflammatory /analgesic activity | Waterm elon | *Citrullus lanatus* | rind | methanolic | Lycopene | 200 and 300mg/kg BW oral administration. | Inflammation induced albino wistar rats. | Reduction in rectal temperature. | (**Kolawole and Dapper, 2016).** |
| | Musk melon | *C.melo.var cantalupensis and C. melo var. reticulatus* | Peel and pulp | Ethanolic extract | Cucurbitacin. B | Oral pre-treatment 95% of extract and a dose of 25 and 50 mg/kg | Carrageenan-induced adult male Sprague Dawley rats | Reduction in the carrageenan-induced oedema | (**Ezzat et al., 2019**). |
| | Bitter melon | *M.charantia* | Leaf | Methanolic extract and ethanol soluble fraction | Charatin, vivine | Orally administered at a dose of 100,200,400,800,1000 and 2000 mg | Mouse-ear edema models | Potent anti-inflammatory agent, in vivo C.acnes-induced inflammatory responses | (**Chuang *et al*., 2020**). |
| Anti-viral activity | Bitter melon | *M.charantia* | leaves | Wild bitter gourd (*M. charantia* Linn.var.abbreviata.ser | Charatin, vivine | Mice were orally administered with 250,500 mg/kg BW of WBGE in 0.2 mL/mouse olive oil daily for two weeks. | Norma mouse model | Regulates mRNA expression | (**Chao et al., 2011**). |
| | waterme lon | *Citrullus lanatus var. citroides* | juice | Wild watermelon juice (WWMJ) | Lycopene | Administration of WWMJ into nasal mucosa 20µl of WWMJ (20mg/kg/day) | Mice infected with mouse-adapted influenza | Inhibits late stages of viral replication and effective anti-influenza activity | (**Morimoto *et al*., 2021**). |

**Biological Activities**

**Antioxidant activity**

The antioxidant activity of melon by-products is due to specific compounds like flavonoids and polyphenols (**Shan *et al*., 2012**). Flavonoids are one of the most effective free radicle scavengers and antioxidants. Pulp and seed powder show antioxygenic solid activity (**Ananthan Padmashree *et al*., 2011**). The reactive oxygen species may react with biological molecules and result in severe cell damage, including oxidation of vital enzymes, DNA damage, and protein damage (**Panda *et al*., 2015**). M. charantia possesses activity against oxidative damage in vitro and in vivo (**Zhonggao *et al*., 2020**). Active components derived from M. charantia include phenols, flavonoids, saponins, triterpenoids, tannins, and other polyphenolic compounds. These chemicals can scavenge free radicals and inhibit the oxidation of lipids, making free radicals a more stable product. Finally, they terminate the free radicle chain reaction. Antioxidant activity was observed in Cantaloupe stem and leaf extract due to the presence of flavonoids (Table 2). The polysaccharides obtained from WMR were found to have good antioxidant activity against ROS hydroxyl-induced DNA damage at a concentration of 5mg/ml (**Romdhane et al., 2017**).

Watermelon seed protein isolates and hydrolysates could be an alternative to synthetic antioxidants and drugs, which might have adverse effects. Natural antioxidants such as polyphenols and vitamins offer health benefits (**Wu *et al*., 2008**). Melon flesh has lower bioactive compounds and antioxidant activity levels than other fruits. Yellow melon pulp had a lower concentration of bioactive compounds than peeled melon and possess low antioxidant activity (**Sonawane *et al*., 2017**). The methanolic extract of C. melo or Cantaloupe has potent hydroxyl radical scavenging action. The activity of cantaloupe extract is mainly due to the presence of phenolic compounds. Cantaloupe stems and leaf extract also showed an increase in antioxidant activity (**Prado *et al*., 2009**).

**Anti-diabetic activity**

The effect of WMR juice ingestion was studied in an experimentally induced type 2 diabetes female albino rat. WMR showed a significant decrease in blood glucose levels, ameliorating structural changes in the pancreas. The increased uptake of blood sugar into the tissue or the stimulation of pancreatic secretions by beta cells are the two main effects of WMR (**Sorour *et al*., 2019**). The α-amylase inhibitory bioactivity of protein hydrolysate from watermelon seed (WMS) was studied, and it served as a helpful material in formulating an anti-diabetic drug. WMS also has hypoglycaemic characteristics and can be utilized to treat diabetic patients (**Arise, 2016**). M. charantia extract significantly increased oral glucose tolerance in diabetic animals and lowered blood glucose, fat content, and body weight. M.charantia juice could facilitate the recovery of damaged beta cells and prevent the death of pancreatic beta cells (Table 2). M. Charantiawas also able to reduce the blood glucose level by inhibiting the activity of α- glucosidase and α-amylase (**Ismail *et al*., 2010**). Oxykine is the main bio-active constituent present in the cantaloupe melon extract having high superoxide dismutase (SOD) activity. Oxykine may be a novel candidate for avoiding diabetes nephropathy (**Ahmed *et al*., 1998**). C.Melovar. agrestis was able to diminish the blood glucose levels in Streptozotocin-Nicotinamide (STZ-NIC)-induced type II diabetic rats (**Altman *et al*., 1985**).

**Antibacterial activity**

WMS includes bioactive components like phenol, flavonoids, saponins, glycosides, and tannins. In relation, it had shown potent antimicrobial activity against E. coli and decreased antibiotic-related side effects (**Sola *et al*., 2019**). Ethanolic extract of WMS can be used as a source of antimicrobial agents. Aqueous and methanolic extract of WMS powder had shown antibacterial effects against *S. aureus*, *E. coli*, *S. Typhi*, and *B. subtilis* (**Hameed *et al*., 2020**). Further, methanolic and hexane extract of the seeds of C. melo L was associated with excellent antimicrobial activity. **Stewart (1999)** evaluated the antimicrobial activity of Momordica charantia L. (concentration of 100mg/ml) and found that it was efficient in inhibiting the growth of all bacteria with different degrees of susceptibility. M.charantia pulp possesses broad-spectrum antimicrobial activity. Strong antibacterial activity was shown by the methanolic extract of M. charantia (**Mada *et al*., 2013**).

**Antiulcer activity**

The hydro methanolic extracts of WMR up to 500 mg/kg body weight had a healing effect on the stomach of albino rats after aspirin-induced gastric ulceration by lowering malondialdehyde (MDA), ROS and increasing the SOD and catalase activity (**Elsayed *et al*., 2022**). Methanolic extract of C. melo. L seeds showed antiulcer activity due decrease in vascular permeability, lipid peroxidation, and

free radicles, along with the strengthening of the mucosal barrier. Triterpenoids and sterols are responsible for these actions (**Gill *et al*., 2011**). The ulcer protective activity of cucumber is due to the presence of alkaloids, polyphenols, and steroids. The compounds also have antioxidant, immunomodulatory, and anti-inflammatory properties (**Patel *et al*., 2010**).

**Anticancer potential of melon by-products**

Many polyphenols (hydrolyzable tannins, phenol acid, and flavonoids) have shown anti-proliferative effects. These substances also activate the xenobiotic detoxification system, modify carcinogens, protect DNA from oxidative stress and inhibit the emergence of mutant genes (**Sabino *et al*., 2015**). According to laboratory and clinical studies, oxidative stress and carcinogenesis are positively correlated (**Sonia *et al*., 2016**). Phototherapeutic products can prevent the growth of tumors and metastasis. MTT (diphenyl-2H-tetrazolium bromide) tests were used to assess the anti-proliferative capacity of melon residue extract in human cell lines, adenocarcinoma, cervical carcinoma, and cancer of the rectum. In all the cancer lines, extracts significantly reduced the growth of cells. Cucurbitacin B is an anticancer agent naturally isolated from the stems of C. melo. Cucurbitacin A and Cucurbitacin E also possess significant anticancer activity (Wright et al., 2007). Anticancer activity against leukemia, lymphoma, melanoma, breast cancer, and prostate cancer has been demonstrated by M. charantia extract (**Grover and Yadav., 2004**). The anti-proliferative potential of isolated polysaccharides from WMR was evaluated, and the results showed that they have substantial cytotoxic action against human laryngeal carcinoma Hep- 2 cells (**Dammak *et al*., 2019**).

**Anti-inflammatory and Anti-pyretic activity**

**Khalid et al. (2021)** reported that WMS extract could be effectively used against inflammation and chronic pain. The anti-inflammatory properties of M. charantia may be due to Cucurbitacin A, B, and C, which is thought to be an inhibitor of the cyclooxygenase enzyme. M. charantia exerts anti-inflammatory activity by the activation of nuclear factor (NF-kB) and Activator protein (AP-1) and by reducing the action of transforming growth factor-βactivated kinase (TAK1). Methanolic extract of C. melo seeds shows analgesic activity (**Yang *et al*., 2018**). C. melo inhibits the leukocyte influx and reduces LTB4 (leukotriene) levels, producing an anti-inflammatory effect (**Gill *et al*., 2011**).

**Antihypertensive activity of melon by-products**

As natural alternatives to synthetic inhibitors for treating and preventing hypertension, the WMR polysaccharides are highly effective at inhibiting the angiotensin 1-converting enzyme (**Romdhane *et al*., 2017**). However, the antihypertensive activity of other melons has not been reported.

**Cardioprotective/anti-hyperlipidaemic/hypocholesterolemic activity**

The phytochemicals in WMR have a strong hypocholesterolemic impact by raising HDL levels and lowering serum levels of LDL, triglycerides, and total cholesterol. The bioactive substances found in WMS, WMR, and flesh induced nitric oxide formation, causing significant vasodilation in the body, and thereby regulating blood pressure (**Fan *et al*., 2020**). WMS juice significantly lowered creatine kinase, triglycerides, and cholesterol, reducing the possibility of cardiovascular disease in healthy experimental rats (**Ibrahim *et al*., 2018**). The continuous utilization of musk melon juice helps in reducing the risk of liver steatosis and atherosclerosis (**Zinchenko *et al*., 1955**). Musk melon's activity is considered very important for managing cardiovascular disease.

**Nephroprotective potential of melon by-products**

There is some hepatoprotective action against ethanol-induced oxidative stress in Wistar rats after administering WMS extract at a 400mg/kg dosage for eight days (**Bazabang *et al*., 2018**). The aqueous extract of WMS was examined in the alloxan-induced diabetic animal model and was found to reduce hepatoxicity and nephrotoxicity (**Zia *et al*., 2021**).

**Anti-angiogenic potential of melon by-products**

The trypsin derived from C. melo L. seeds showed strong anti-angiogenic activity in the 3D culture of human umbilical vein endothelial cells (**Rasouli *et al*., 2017**).

**Anti-Hypothyroid activity**

Administration of musk melon (C. melo. L) fruit peel extract significantly enhanced both the thyroid hormones (T3 and T4) with a corresponding decrease in tissue lipid peroxidation, indicating their thyroid stimulatory effect (**Naito *et al*., 2005**).

**Anti-viral activity**

The research indicates that Momordica I and II are not as effective against viruses like HSV-1 and SINV9 as ethanol extracts from the leaves and stems of M. charantia (**Beloin *et al*., 2005**). A variety of compounds isolated from M. charantia have anti-viral activity, mainly proteins, and peptides (**Basch et al., 2003**). Momordica kills the Coxsackie virus by inhibiting transcription and translation, providing direct protection against CVB3 infection (**Jia *et al*., 2017**).

**Anti-obesity properties of melon by-products**

Long-term administration of M. charantia extract to rats could decrease visceral fat mass and energy efficiency because it may operate as a potent inhibitor of lipogenesis. It may also reduce hyperlipidemia and hypercholesteremia in obese hamsters (**Chan *et al*., 2005**). Elevated catecholamines and fatty acids imply that the lipolytic process and sympathetic activity may boost the proposed anti-obesity mechanism (**Chen *et al*., 2005**).

**CONCLUSION**

WMSs and WMR are possible sources of functional components that can be used to produce value-added products. Utilizing melon by-products is essential to managing food waste and can help numerous industries, including food, pharmaceutical, and cosmetics. The chemical composition of melon by-products showed that they are a good source of essential nutrients. The melon seed contains numerous bioactive components such as phenolic compounds, sterols, phospholipids, and tocopherol. Bioactive compounds are associated with numerous bioactivities such as anticancer, antiviral, antibacterial, antiulcer, antioxidant, and anti-diabetic activity.

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