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A review of proximate, functional properties and health benefits of *Cucumis melo* L.

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Cucumis melo L. (melon) has become one of the major food waste in agricultural industries whereby many of this fruits are thrown away at immature stage and in some cases their peels and seeds are not well utilized. *Cucumis melo* L. wastes contain significant amount of nutritional and functional ingredients that can be used in food formulations. In this review, maazoun melon variety were used to compare the proximate content, minerals, and functional properties with other different varieties of melon. Some of the health benefits of *Cucumis melo* L. were also included in this review. This review have demonstrated that waste of *Cucumis melo* L. provides excellent nutritional and functional properties which can be utilized in various food applications in food industry.

Keywords: *Cucumis melo* L., melon, maazoun melon, peels, seed and flesh

INTRODUCTION

Melon is a member of the genus Cucumis, subtribe Cucumerinae, tribe Melothrieae, subfamily Cucurbitoideae, and circle of relatives Cucurbitaceae. *Cucumis melo* L. is one of the species of melon that evolved into many cultivated variations (Yanty et al., 2008).To improve the growth of melons which comes with better taste, scientists came up with many new hybrid of melons. Melons are also good to be eaten with salads, custards, chilled or to be drunk as fruit juice. Melon plantations is one of the main sources of agricultural waste, whereby high quantity of immature melon fruits is discarded to reduce competition among the fruits (Morais et al., 2015). However, the fruit waste has excellent potential in providing benefits to human health as it is high in fibre, vitamins, oils, bioactive compounds and minerals (Nazeem et al., 2016).

Food waste is defined as the processed or fresh parts of food that are wasted for any purpose in the gap between farm and consumer plates (Liara, 2013). In some countries, people are facing malnutrition and starvation while in some other countries overweight and obesity. In addition, food waste is still a major issue in our nations leaving it with no proper solution. Approximately 23,000 tonnes of waste products are produced daily in Malaysia, where this amount is estimated to reach 30,000 tonnes by the year 2020 (Nazeem et al. 2016). More food waste accumulates due to underutilization of foods that are available. Since food waste represents environmental, economic and social issues, it becomes one of the main concerns around the world (Ahmad et al., 2011). As the potential products are inside the chain of the supplemental worth of product, food wastes will be maintained in circular systems. The agricultural waste management can elevate nation's competitiveness, develop new jobs opportunity and increase property expansions while helping food manufacturers in providing healthy food products for their consumers by using up the benefiting by product from plants (Morais et al., 2015).

BOTANICAL DESCRIPTION

Cucumis melo L. is usually grown from the seed. Melons are monoecious plant that has both male and female flowers which need to be watered mildly (Sasikumar, 2011). This type of melon can be easily grown in sandy soils. Its cultivation re- quires dry riverbeds to grow better. Usually, melon will be kept at room temperature for ripening. There are two varieties of melons which are those with clean skin and the other with meshed skin (Thakur, 2015). Melons are grown in many parts of India mainly in the warm and dry North-Western areas where melon trees were grown tropically since long time ago. However, Biswas (2006) reported that it is far mentioned in a few books melons are native of South Asia, which has come from the foot of the Himalayas to Cape Comorin, wherein it grows wild but it is cultivated inside the temperate and warm place in the earth. Domestication of melon might also have occurred thoroughly in India, especially North and central India. Many types of melons cultivated in North and Middle India vary in length, pores, skin, pulp, colour and taste (Joshi, 2000). Melons are appreciably cultivated in the course of India specifically inside the warm and dry North-Western regions. Manis Terengganu melon varieties are specially cultivated in Terengganu, Malaysia where approximately only one of out of 6 fruits that grows in one tree survives, while the rest are thrown at immature stages to restore the quality of mature fruit produced (Nazeem et al., 2016). Matured Manis Terengganu melon has clean and yellow coloured skin while the immature ones look pale green in colour (Thakur, 2015).

Melons that are grown by treating it with more water confirmed higher yields, better sugar contents and better colour than the ones grown in drier area. Propagation is done by using seed and vegetative approach and through tissue culture (Pullaiah, 2006). Seed oil, pulp, seeds, and roots are the major used parts of melon tree. Moreover, melon juice can cure some conditions like overweight, urinary tract infection, loss of appetite, stomach acidity, constipation and ulcers (SasiKumar, 2011). Melons can release tiredness by relieving the body heat. It is also an efficient laxative. It is basically high in vitamin such as vitamin A, B and C. Melon has sufficient amount of potassium that is beneficial to reduce blood pressures, stroke, and adjusting heartbeats (Nazeem et al., 2016). The melon seeds can be roasted slightly and eaten as snack, besides they also are packed with unsaturated fatty acids. The sugar content of melon will not increase after the fruit has been removed from the vine, so to get sweet melon is important for the fruit to stay at the vine till completely mature, but in order to capitalise on beneficial early-season markets, or to enhance shelf-life, melons are often harvested before they have reached maturity (Singh et al. 2004).

Melon are well known for having astringent, diuretic, galactagogic, demulcent, emmenagogue, aphrodisiac, and cooling characteristics (Parrotta, 2001). Melon has been used for centuries to treat some kidney problems, urinary ulcers, cough, fever, bile obstruction, and many others (Prajapati, 2007). Melon has nephroprotective, anti-inflammatory,antimicrobial, antihyperlipidemic antioxidant, diuretic, thyroid stimulatory, analgesic, anthelmintic¸ and cytotoxic activity that were proven by research (Nazeem et al., 2016). The numerous types of melon show high-quality diversity in growth whereby the fruits are greater in the length and shape. For instance, some kinds are as small as an olive, big as gourd; a few are globular, others egg-shaped, spindle-shaped or serpent like, the outer skin can be clean, netted, ribbed, furrowed and variously coloured. The flesh can be white, greenish, or orange when ripe, scented or scentless, sweet or tasteless; a few are bitter and even nauseous (Parrotta, 2001).Melons are annual climbing herb with an angular and scabrous stem (Biswas, 2016). The leaves are approximately 7.5 cm, orbicular-reniform in define, 5 angled, lobed, scabrous on both surfaces and also regularly with tender hairs, lobes neither deep nor acute and 5 cm length of petiole (Pullaiah, 2006).

The fruits can be round ovoid, elongated, contorted, glabrous or furry, neither spinous nor tuberculate (Pullaiah, 2006) and 5 cm in length and 4 cm in diameter, yellow with green colour stripes while young. Seeds are obovoid and rounded at apex. This fruit usually grows in the August and September (Parrotta, 2001). Flowers are small, yellow, unisexual plant life comprises bell-shaped corollas, male flowers borne in small clusters and female are solitary. Male flower has 3 stamens, while the female flower has the ovary and three cells. Flowering in Middle India is between July and August (Biswas, 2006).

PROXIMATE ANALYSIS OF *Cucumis melo* L. SEED

Proximate analysis is an important view to determine nutritional importance and to evaluate the quality of food. Mallek-Ayadi et al., (2018) studied on the proximate analysis of maazoun

melon seeds to determine seeds nutritional quality. The authors stated that since high moisture content may perish the seeds by microorganisms' activity, it is important that melon seeds has lower water activity (0.44) and moisture content (7.16%) to increase the shelf life of seeds. Mallek-Ayadi et al., (2018) proved that the maazoun melon seeds (30.65%), have oil yield higher than winter melon (25%) (Yanty et al., 2008) and Kalahari melon (30.50%) (Nyam et al., 2009). Maazoun melon seeds can be well utilised in oil industries for oil production. Maazoun melon seeds had higher protein content (27.41%) (Table 1) than the AF-522 variety melon seeds (de Melo et al., 2000) and kalahari melon (Nyam et al. 2009) indicating (14.91% and 24.50% respectively). García-Agui-lar et al., (2015) reported that almond seeds had only 19.91% of protein content which is lower than maazoun melon seeds. The total carbohydrate content included the non-digestible parts and digestible parts of carbohydrates found in melon seeds, (Siddeeg et al., 2014). Mallek-Ayadi et al., (2018) reported that the Bra-zilian melon seeds and AF-522 melon seeds had higher total carbohydrate content (39% and 29.96% respectively) than maazoun melon which is 22.94%.

The maazoun melon seed contained 25.32% dietary fibre which includes insoluble constituents (22.18%) and 3.14% of soluble con-stituents (Mallek-Ayadi et al., 2017). Overall die-tary fibre in maazoun seeds is above of the total dietary fibre content in winter melon seeds which is 23.30% (Yanty et al., 2008) and ChunLi melon seeds (19.52%) (Mian-hao and Yansong, 2007). Navarro-González et al., (2011) stated that dietary fibres are important in maintaining a better human health whereby an efficient consumption of dietary fibres can reduce the risks of certain diseases like overweight and diabetes.

Table 1. Proximate composition in maazoun melon seeds

Component (%)[a]	Content
Moisture	7.16±0.14
Water activity	0.44±0.00
Fat	30.65±0.6
Proteins	27.41 ± 0.53
Ash	4.83±0.12
Total carbohydrate	29.96±0.55
Total dietary fiber	25.32±0.13
Soluble dietary fiber	3.14±0.05
Insoluble dietary fiber	22.18±1.02
Total polyphenols	304.10±0.83
Total flavonoids	87.52±0.17

Al-Sayed and Ahmed (2013) stated that Nigerian melon seeds had lower ash content at 1.8% as com-pared to maazoun melon that has 4.83% of ash content in it. As a whole, the valuable supply of nutrient present in maazoun melon like the protein, ash, fibre and fat can contribute to source of utilisation in many food manufacturing industries to produce a value added and functional foods.

Proximate analysis OF *Cucumis melo* L. Peel

Nyam et al., (2009) stated that melons are beneficial fruit that is packed with enough nutrients needed by a human for a daily basis. The study on proximate composition in peels of maazoun melon done by Mallek-Ayadi et al., (2017) is represented in Table 2 shows significantly low moisture content (16.95%) which is beneficial in increasing its shelf life. Mallek-Ayadi et al., (2017) studied that the protein content in maazoun peels (7.48%) was lower than that of in sharlyn melon peels (9.07%), which was reported by Al-Sayed and Ahmed (2013).

However the protein content in melon seeds was higher than melon pulp which is 7.02% (Atef et al., 2013). Besides that, it was reported by Ajila et al., (2010) that the protein amount in melon peels was higher than that of mango peels and cactus peels (3.6% and 3.77%, respectively). The maazoun melon peels have higher lipid content (2.12%) in comparison to the sharlyn melon peels (1.58%) reported by Al-Sayed and Ahmed (2013).

Mallek-Ayadi et al., (2017) stated that the ash content in melon peels (3.67%) are higher than that of pumpkin (2.46%) and watermelon peels (3.07%) as reported by Atef et al., (2013). In contrast, the watermelon rind has higher totalcarbohydrates content (73.18%) than maazoun melon peels (69.77%) (Hoque & Iqbal, 2015). Carbohydrates are capable of regulating the immune system by reducing inflammation and triggering macrophages. Plant polysaccharides are important for better dietary functions and therefore are beneficial for human health support (Simpson and Morris, 2014).

Maazoun melon peels contain 41.69% of dietary fibre, which consist of 37.58% of insoluble dietary fibre and 4.38% of soluble dietary fibre (Mallik-Ayadi et al., 2017). The sharlyn melon peel and watermelon rind have 29.57% and 17.28% of fibre content

respectively which is much lower than maazoun melon peel (Mallek-Ayadi et al., 2017). Dietary fibre is important in for human health and bodily function, as it reduces the risks of diabetes, cancer and heart diseases (Navarro-González et al., 2011). Maazoun melon peels can be used in some bakery products, cornflakes and yogurts production to increase the fibre content and also to increase the biological process quality of food products. Due to its fraction of ash, sugar and fibre in maazoun melon peels could be considered as a valuable nutrient supply.

Table 2; Proximate composition of maazoun melon peels

Component (%)[a]	Content
Moisture	16.95±0.14
Total protein	7.48±0.53
Fat	2.12±0.6
Ash	3.67±0.12
Total carbohydrate [b]	69.77±0.55
Total dietary fiber	41.69±1.03
Soluble dietary fiber	4.38±0.08
Insoluble dietary fiber	37.58±1.12
Total polyphenols[c]	332±0.32
Total flavonoids [d]	95.46±0.15

[a]% of dry matter basis.
[b]Total carbohydrate obtained by difference.
[c]mg GAE/100 g extract
[d]mg QE/100 g extract

Mineral content in *Cucumis melo* l. Seeds

Minerals are vital elements like vitamins that are needed by human to sustain healthier life. Mallik-Ayadi et al., (2018) performed analysis on the mineral content in *Cucumis melo* L. seeds and found that potassium is the prevailing mineral element in maazoon melon seeds (1148.75 mg/100 g), followed by magnesium (1062.25 mg/100 g) and calcium (506.13 mg/100 g) in descending order as shown in Table 3. The composition of minerals in maazoun melon seeds has proven that potassium and magnesium are the main minerals as reported by Siddeeg et al., (2014).

The amounts of potassium (K), magnesium (Mg) and calcium (Ca) in melon seeds were more than those reported for pumpkin seeds (982, 483 and 130 mg/100 g, respectively) for comparison (El-Adawy and Taha, 2001). Irrelatively low concentrations of iron, zinc, manganese and copper minerals were present in maazoon melon seeds. Therefore, *Cucumis melo* L. seeds are an adequate supply of minerals of potassium, calcium and magnesium. Potassium, in fact, could play a vital role in regulating heartbeat, magnesium works with calcium to maintain healthy bones. Calcium is a good supply for calcium deficiencies prevention and treatment (Bahloul et al. 2014).

Table 3; Mineral content in maazoun melon seeds

Mineral	Value(mg/100 g)
Potassium	1148.75±1.53
Magnesium	1062.25±0.72
Calcium	506.13±1.52
Sodium	336.5±0.72
Iron	2.69±0.81
Zinc	2.34±0.64
Manganese	1.25±0.15
Copper	0.53±0.12

Mineral content in *cucumis melo* l. Peels

One of the element that is not synthesized by the human body are minerals. Major minerals needed by human are calcium, phosphorus, potassium, sodium and magnesium which are naturally packed in most melon varieties. The maazoun melon peels contain a significant amount of minerals like sodium, calcium, magnesium and potassium. Most calcium was found in melon peels (1153.12 mg/100 g). Calcium is a very important mineral that aids the development of healthy bones and teeth. In addition, calcium is also important for high blood pressure treatment and prevention, stabilising vascular membranes and lowering vasoconstriction cells (Houston, 2005).

The second highest mineral found in melon peels is potassium which is 884.68mg/ 100g. Potassium is a beneficial micronutrient that helps to regulate heartbeat. In melon peels, calcium and potassium may enhance the useful health effects of phytochemicals such as phenolic compounds. For example, 389.65 mg/100 g of magnesium and 144.83 mg/100 g of sodium were found in melon peels. Magnesium gives ionic equilibrium that reduces the chances of blood pressure and enhances the vaso- relaxation when magnesium combines with other ions like calcium, sodium and potassium (Mallek-Ayadi et al., 2017).

In addition, in certain enzyme reactions, magnesium and potassium are crucial (Siddeeg et al., 2014). Therefore Mallek-Ayadi et al., (2017) stated that melon peels have adequate supply

of minerals, that nutritionally maazoun melon peel have extensively high quantities of iron, manganese, zinc and copper (1.23, 0.41. 0.40. and 0.27 mg/100g respectively). *Cucumis melo* L. peels can be well utilized to be added as additive in fitness bar or in energy drink to substitute the minerals that depleted in athletes during sports.

Table 4; Mineral content in maazoun melon peels

Mineral	Content(mg/100 g)
Calcium	1153.12±0.15
Potassium	884.68±1.03
Magnesium	389.65±0.52
Sodium	144.83±0.12
Iron	1.23±0.08
Manganese	0.41±0.15
Zinc	0.40±0.46
Copper	0.27±0.02

Water and oil retention in *Cucumis melo* l. Seeds

Functional properties of food is important in determining the possible shelf-life of certain food where water-holding and oil holding capacity comes into essential factor. The determination of functional properties of melon seeds were carried out by Mallek-Ayadi et al., (2018). Interaction between nature of the food matrix components physicochemical properties and structure is identified through the functional properties (Lakshmi & Kaul, 2011). Besides, seeds' water-absorbing ability determines their maximum degree of utilisation in foods as an ingredient for food that need acceptable texture to be maintained. Melon seeds showed water retention capacity of 2.33 g water / g seed.

Mallek-Ayadi et al., (2018) reported that this was slightly lower than the watermelon and pumpkin seed values reported by El-Adawy and Taha (2001) (2.55 g water / g and 2.51 g water / g, respectively). Melon seeds will retain up to two times their weight in oil (2.59 g oil / g) with regard to oil retention capacity. These properties can be used to strengthen fat retention capacity of foods (such as meat products) that are generally lost throughout the preparation process. This will be useful in maintaining flavour and improving yields (Siddeeg et al., 2014).

Water and oil retention in *Cucumis melo* L. Peels

Maazoun melon peels had water retention capacity of 5.36 g water / g peel. Mallek-Ayadi et al. (2017) stated that maazoun melon has lower water absorbing capacity compared to watermelon rind and sharlyn melon peel (7.13 and 7.70g water/g peel respectively). Mallek-Ayadi et al. (2017) stated that the maazoon melon peel oil retention capacity value (2.23 g oil / g peel) (Table 5) was consistent as that of sharlyn melon peel (2.24 g oil / g peel) but above that of watermelon rind which is 1.65 g oil / g rind), in line with the study done by Al-Sayed and Ahmed (2013).

In stabilisation of high fat foods and emulsifications, it is important that ingredient that can retain oil is added into it. Maazoun melon peels have the capability to retain oil two times of their mass. These oil retaining properties of the peel can be well used in boosting food fat retention capability like in meat products losing the juiciness in preparation process. This may be useful in maintaining flavour and improving yields (Siddeeg et al. 2014).

Table 5; Water retention, oil retention and colour of maazoun melon peel

Parameter	Value
Water retention capacity (g water/g peel)	5.36 ± 0.17
Oil retention capacity (g oil/g peel)	2.23 ± 0.11
Color	68.63 ± 0.98
L*	-2.36 ± 0.04
a*	30.19 ± 0.05
b*	39.89 ± 0.51
∆E	39.89 ± 0.51

TPC and TFC in *Cucumis melo* L. Seeds

Ahmad et al., (2011) stated that phenolic compounds include the common groups of secondary plant metabolites that has bioactive potential associated with their antioxidant activity. The total phenolic content (TPC) of melon seeds Maazoun was 304.10 mg/100 g (Mallek-Ayadi et al., 2018). This amount is higher than for cantaloupe seeds (285 mg/100 g) (Ismail et al., 2010) and for winter melon seeds (80 mg/100 g) reported by Zeb (2016). Phenolic compounds have the tendency to shield cellular components damaged due to free radicals by using their various types of chemical structure in defending free radicals (Bahloul et al., 2014). Certain risks of chronic diseases can be reduced like cardiovascular diseases and cancer by the intake of foods that contain polyphenols (Liara et al., 2013). The maazoun melon seeds contain 87.52 mg/100g

of total flavonoid content (TFC). Ismail et al. (2010) reported that flavonoids are one of the most common and highly distributed cluster compounds of the plant known as phenolic compounds. These compounds are one of the antioxidants that are effective.

TPC and TFC in *Cucumis melo* L. Peels

Bahloul et al., (2009) stated that the phenolic compounds that are found in fruits have an essential function in preserving the flesh from the infestation of insects and microorganisms. Phenolic compounds are also important to show that the fruit is ripe and ready for harvesting (Jeong et al., 2004). According to the colorimetric methodology of Folin–Ciocalteu, the total polyphenol content of maazoon melon peel is 332 mg/100 g extract (Mallek-Ayadi et al., 2017) as shown in Table 2. A similar value of total polyphenols for watermelon peels was found by Duda-Chodak and Tarko (2007) (335.3 mg/100 g extract). Cantaloupe peels, however, contain significantly higher total polyphenols, which is an extract of 470 mg/100 g as reported by Ismail et al., (2010).

Ismail et al., (2010) stated that the melon peel is most likely high in phenolic compounds as compared to melon seeds and melon flesh (285 and 168 mg/100g respectively). Intake of polyphenols through consuming more fruits and vegetables can prevent chronic diseases like cancers and heart diseases (Aydin and Gocmen, 2015). Bahloul et al., (2009) stated that the most found clusters of antioxidant in plants are the flavanoid compounds. Mallek-Ayadi et al., (2017) reported that 95.46mg/100g of total flavonoid content was found in the melon peel. Morais et al., (2015) reported that the Brazilian melon peel extract has higher total phenolic content (106.18 mg/100 g) than maazoun peel melon extract. Apak et al., (2007) stated that it is important to note that the aluminium chloride methods which are used to determine total flavonoids allow to identify approximate value of total flavonoid content that are present, but not favourable in measuring the types of flavonoids that are present. Folin-Ciocalteu calorimetric method does not show the types of phenolic compounds that are present in the fruit peel. Following this, Mallek-Ayadi et al., (2017) conducted the identification of phenolic compounds that present in the peel by using HPLC equipment.

Identification of phenolic compound using hplc for *Cucumis melo* l. Seeds

Phenolic compounds can be a option to reduce oxidative cellular injury and lipid peroxidation in human (Arora et al., 2011). A total of 15 phenolic compounds were found by Mallek-ayadi et al., (2018) as shown in Table 6, with seven phenolic acids such as (procatechuic, chlorogenic, gallic, vanillic, phenylacetic acids 4-hydroxybenzoic, and rosmarinic,), five flavonoids (luteoline, flavone, amentoflavone, apigenin, and naringenin-7-Oglycoside,), one phenolic monoterpene (hydroxytyrosol), one secoroid (oleuropin) and one stilbenoid (resveratrol). The main phenolic category found in the seeds are phenolic acids (47.78 %)> flavonoids (27.15 %)> secoroid (8.62 %)> and stilbenoid (8.31 %).

Apart from that, the leading phenolic compounds found in the seeds are gallic acid (4.24mg.100g-1),4-hydroxybenz acid(3.28mg.100g-1), naringenin-7-O-glycoside (4.30 mg.100g-1) and vanillic acid (3.87 mg.100g-1). The quantity of hydroxyl acid found in honey dew (2.18 m g.100g-1) seed is lower than that in maazoun melon seed. Bahloul et al., (2014) stated that hydroxybenzoic acid and vanillic acid has antifungal and antimicrobial properties.

Besides, naringenin-7-Oglycoside is a flavonoid that has antioxidant and anticancer effects (Mallek-ayadi et al., 2017). The main compound in melon seeds was naringenin-7-O-glycoside (4.30 mg.100g-1) while 3-hydrohybenzoic acid (33.45 mg.100g-1) is the highest compound in melon skin. As for melon peels, the most phenolic compounds present in melon seeds are phenolic acids. HPLC results for the phenolic compounds in melon peels studied by Mallek-ayadi et al., (2017) is illustrated in Table 7. The results show that melon seeds were associated as phenolic compounds with a significant supply of biologically active substances. In order to increase shelf life and reduce oxidations in food, manufacturers now focus on the addition of natural phenolic compounds derived from plants to produce better quality food products. Polyphenols are antioxidant agents that are intentionally added into value added food products to reduce off-flavour build ups during storage. Melon seeds have the potential as dietary supplement due to their high phenolic compound range.

Table 6; The phenolic contents(mg/100g) and percentages(%) of phenolic compounds in seeds of maazoun melon

Phenolic compounds	Content	Percentage
Phenolic acids	16.79± 0.48	47.78
Gallic acid	4.24± 0.03	12.07
Procatechuic acid	0.93± 0.00	2.65
Chlorogenic acid	1.25± 0.01	3.56
4-Hydroxybenzoic acid	3.28± 0.03	9.33
Vanillic acid	3.87± 0.02	11.01
Rosmarinic acid	1.87± 0.02	5.32
Phenylacetic acid	1.35± 0.05	3.84
Flavonoids	*9.54± 0.15*	*27.15*
Naringenin-7-O-glycoside	4.30± 0.00	12.24
Luteolin	2.10± 0.01	5.98
Apigenin	0.50± 0.04	1.42
Flavone	0.86± 0.04	2.45
Amentoflavone	1.78± 0.24	5.06
Phenolic monoterpene	*1.28± 0.11*	*3.64*
Hydroxytyrosol	1.28± 0.11	3.64
Secoroidoid	3.03±0.13	8.62
Oleuropein	3.03±0.13	8.62
Stilbenoid	*2.92±0.24*	*8.31*
Resveratrol	2.92±0.24	8.31
Unknown	1.58± 0.06	4.49
Total	35.14±0.74	100

Table 7; The HPLC analysis of phenolic compounds in ethanol extract in maazoun melon peels and concentration in (mg/100g).

No.		Compounds	Concentration
1	Gallic acid	Hydroxybenzoic acids	12.07± 0.12
2	Hydroxytyrosol	Phenylethanoid	9.11± 0.26
3	Protocatechuic acid	Hydroxybenzoic acids	3.46± 0.81
4	Tyrosol	Phenolic alcohol	11.35± 0.03
5	Chlorogenic acid	Hydroxycinnamic acids	8.25± 1.01
6	4-Hydroxybenzoic acid	Hydroxybenzoic acids	8.62± 0.30
7	Isovanillic acid	Hydroxybenzoic acids	23.70± 0.04
8	3-Hydroxybenzoic acid	Hydroxybenzoic acids	33.45± 0.37
9	Luteolin-7-glycoside	Flavones	16.51± 0.15
10	Naringenin	Flavanone glycosides	11.58± 0.11
11	Apigenin-7-glycoside	Flavones	29.34± 0.17
12	Oleuropein	Secoiridoids	18.88± 0.29
13	*m*-coumaric acid	Hydroxycinnamic acids	19.91± 0.37
14	Phenylacetic acid	Benzeneacetic acid	3.27± 0.95
15	Luteolin	Flavones	6.73± 0.18
16	Pinoresinol	Lignan	1.92± 0.07
17	Flavone	Flavones	13.51± 0.32
18	Amentoflavone	Flavones	2.69± 0.07

Identification of phenolic compound using *Cucumis melo* l. Peels

Bahloul (2014) stated that the phenolic compounds, organic acids and sugars are the compounds that add aroma and flavours to the fruits. The melon peel extract contains nine chemical categories of phenolic compounds, including phenolic acids, flavones, lignan and secoiridoids.

A total of 18 phenolic compounds was identified in maazoun melon peel extract by Mallek-ayadi et al. (2017), whereby in sharlyn melon peel 4 phenolics were recognised by Al-Sayed (2013). The maazoun melon peel was rich in flavanoids and hydroxybenzoic acid, and the most common phenolic compound found in melon peel was the 3-Hydroxybenzoic acid (33.45 mg/100 g). The result is in line with the report of Liara (2013) which stated that most found phenolic compound in watermelon rind and sharlyn melon peel was the hydroxyl acid. Tadmor (2010) reported that in olive and grapefruit, 3-Hydroxybenzoic acid was detected, where this compound possesses anti-fungal, anti-mutagenic and anti-microbial activity. It has antimutagenic, antimicrobial and antifungal activity (Tadmor, 2010).

Mallek-ayadi et al. (2017) stated that there were m-coumaric acid (19.91mg.100g) and isovanillic acid (23.70mh/100g) in melon peel extract. Isovanillic acid possesses the antioxidant and antibacterial activity (Ismail. 2010). Chlorogenic and coumaric acids are the types of carboxylic acids that can have positive effects to human by reducing the risks of cancer and cardiovascular diseases (Apak. 2007). Mallek-ayadi et al., (2017) stated that there were adequate quantity of gallic acid (12,07 mg/100 g), tyrosol (11,35mg/100 g) and hydroxytyrosol (9,11 mg/100 g) in the peels of maazoun melon.Phenolic compounds can possess a good anti-inflammatory, anti-cancer and anti-bacterial activity that protects against coronary artery disease and prevents diabetic neuropathy (Laksmi & Kaul, 2011).

Apart from that, significant quantities of luteolin-7-glycoside (16.51 mg/100 g), apigenin-7-glycoside (29.34 mg/100 g), naringenin (13.51 mg/100 g) and flavone (11.58 mg/100 g) were identified in maazoun melon peels. Liara (2013) reported that luteolin-7-glycoside and apigenin-7-gycoside has antitumor and anti-inflammatory effects on human. The total phenolic content received by applying Folin Ciocalteu assay was (332 mg/100 g) higher than the phenolic compounds obtained through HPLC techniques (234.35 mg/100g).

This proves that spectrophotometric analysis is not accurate enough to be quantified whereby Nazem et al. (2016) stated that some other compounds that were present in the extract like pectins and sugars reacts with the Folin Ciocalteu reagent and may exaggerate the samples phenolic content. Bahloul et al. (2009) reported that in some cases in order to prevent off-flavour and to increase the shelf life of food, polyphenols may be added since they possess good antioxidant and anti-bacterial properties. Maazoun melon peels therefore can be well utilised as a useful food ingredient as a bioactive substance or as a food additive to improve food quality.

COLOUR OF *Cucumis melo* l. SEED

Most vegetables and fruits obtain colour from antioxidants that also helps in lowering the risk of certain diseases in human. Melon seed from maazoun variety showed lower L* and a* values basically but maazoun melon have higher L* value than tibish melon seed (Siddeeg et al. 2014). This suggests that based on the additional yellow-coloured melon seeds from the maazoun selection and in the alternative aspect, the presence of yellow pigments such as carotenoid compounds was identified by Mallek-Ayadi et al., (2018).

It should be noted that the different cultivars of melon fruits and their growing conditions result in variations in colour between melon seeds (Joshi, 2000). Caliskan and Polat (2012) reported that the most parameters affecting fruit pigments are environmental factors, genotype and post-harvest conditions. However, a * value could also be affected by storage times and throughout maturation, not only by the cultivar effect. On the other hand, the colour of melon seeds may attribute natural colour to some food products by the addition of melon seed flour.

Colour of *Cucumis melo* L. Peel

Colour plays an important function in fruit acceptability in terms of ripening stage. The study on colour measurement by Mallek-ayadi et al. (2017) is indicated in Table 5. The *Cucumis melo* L. a* peels value (-2.36) exceeded those of ravi melon peels (-7.64) (Parveen et al., 2012) and Lyukui melon peels (-7.33) (Chen et al. 2009). However, the peel of

maazoun melon was greener than the peel of hami melon (Wen et al. 2015), showing a higher a* value (7.47). In addition to the resulting variety, during ripening and storage periods, the a* value may be affected due to the breakdown of chlorophylls in the melon skin, (Joshi, 2000).

The ravi melon peels (Parveen et al., 2012) have higher b* value (63.04) indicating a more yellow colour on the skin, while maazoun melon peel showed a more yellowish skin (30.19) in comparison to hami melon which was (24.76) (Wen et al., 2015), The lightest colour of melon was the maazoun melon, compared to the other two melons. In fact, the maazoon melon peel L* value (68.63) was higher than that of ravi melon peels (66) (Parveen et al., 2012), hami melon peels (58.87) (Wen et al., 2015) and Lyukui melon peels (35.35) (Chen., 2009). The difference in colour of fruits indicates the fruits are grown in different growing conditions and cultivars. Apart from that, Ngo et al., (2007) studied that mixtures of carotenoids, chlorophyll and flavonoids played an important function in fruit colour changes during maturation.

ANTIMICROBIAL ACTIVITY

Antimicrobial agents are one of the food industry demands nowadays where synthetic antimicrobial agents is banned in most of the country due to side effects. Scientist now focus on the naturally derived antimicrobial agents to increase shelf life of food product and to reduce harm to consumer health. The aqueous, heptane, petroleum ether and acetone extract of plant of *Cucumis melo* L. were screened for antibacterial and antifungal activity by Thakur (2015). Maximum condition of inhibition was shown with the aid of entire plant and fruit extract of *Cucumis melo* L. with aqueous and acetone with C. albicans and E. coli, respectively. Very indigent feedback was received with acetone and aqueous extract in different bacterial and fungal stains. Highest inhibition in the complete extract of Pergularia daemia with heptane with E. coli and C. albicans was found, respectively. SasiKumar (2014) discovered that the extract and fractionates of fresh *Cucumis melo* L. confirmed a compelling and exceptional activity against all microorganisms.

Anti-hyperlipidemic activity

Hyperlipidemic agents are lipid-reducing pharmaceutical drugs that are used to treat high levels of fats in human (Arora et al., 2011). Hyperlipidemia is a disease where lipids and lipoproteins are in the increased amount than the regular quantity in body. Bidkar (2012) found a significant reduction in body weight gain ($P<0.01$), serum lipid profile such as total triglyceride (TG), cholesterol, atherogenic index(TC), low density lipoprotein cholesterol (LDL-C) level, and increased serum high density lipoprotein cholesterol (HDL-C) levels in a month of treatment with *Cucumis melo* L. fruit peel (CMFP) compared to the control group of hyperlipidemics. When treated with CMFP methanolic and aqueous extract and standard drug, the faecal excretion of bile acids and sterols was further increased. A higher anti-hyperlipidemic activity is shown on groups treated with 500mg/kg dosage of CMFP extract. Thus, CMFP can be used as one of the ingredient in food product such as protein powders or other supplemental foods to naturally reduce the elevated lipid levels in human.

Thyroid stimulatory effect

Thyroid are tiny gland that is situated near to throat which mostly are in butterfly shapes and it stimulates hormones that controls the usage of energy, balances body temperature, mood, and healthy weight (Atef et al., 2013). Prajapati et al. (2007) studied peel extracts *Cucumis melo* L. (CM) fruits that considerably accelerated both the thyroid hormones (T3 and T4) with a concomitant lower in tissue LPO. In serum lipid profile CM reduced the concentrations of overall cholesterol and occasional-density lipoprotein-cholesterol. The results revealed the thyroid stimulatory and antiperoxidative characteristics of peel extracts of *Cucumis melo* L. fruits.

CONCLUSION

Based on this review, *Cucumis melo* L. possess good functional properties which is beneficial to be applied in various food applications. The review also proves that *Cucumis melo* L. is a favourable source of essential minerals such as calcium, magnesium, potassium, sodium and other trace minerals. Apart from that, *Cucumis melo* L. has shown to be an excellent supply of antioxidant, antimicrobial properties, antihyperlipidemic properties, and thyroid stimulatory factor. It can be concluded that *Cucumis melo* L. provides important functional properties and nutrient that can be well exploited to aid various food related diseases like obesity, cancer, diabetes, and cardiovascular diseases in human.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

MS perform electronic database search and wrote the manuscript. NS, NH and ZZ supervised, design the experiment and reviewed the manuscript. All authors read and approved the final version.

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