

## Nutritive Value and Improving Palatability of Bitter Melon (*Momordica charantia* L.)

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**Abstract:** Bitter melon (Carvilla), is a popular traditional medicinal vegetable in tropical and subtropical countries. A larger population of people does not like the bitterness of this fruit and processing into beverages is believed to increase its palatability and acceptability. The aim of this work was to determine the chemical composition of the carvilla fruits and as a trail to remove the bitter taste to use it as a food component in the preparation of carvilla drink with tea as well as spearmint. The obtained results indicated that the fresh and dry (with bitterness T1 and without bitterness T2) carvilla fruits had high levels of ash and protein contents (8.54, 8.32 and 7.92% and 13.21, 13.42 and 13.14%, respectively). The anti-oxidant activity of fresh and dry carvilla fruits (T1) were higher than carvilla fruits (T2). Carvilla is also a good source of mineral elements, especially potassium, calcium, magnesium, iron and zinc. Sugars such as maltose, sucrose, arbinose, fructose, stachyose, glucuronic and galcturonic represented in high ratios of fresh carvilla while decreased after soaking and drying. e-vanillic, pyrogallol and benzoic acid were the major phenolic compounds, whereas, rosmarinic, quercetrin, spiridine and acetin were the predominant of flavonoid compounds, which decreased after soaking and drying. Vitamins B3, B6, B12 and K were the predominant vitamins found in carvilla fruits. The IC<sub>50</sub> of fresh and dried bitter melon extract showed high active as anti-cancer for lung cell while dried bitter melon free from bitterness did not show any effect. The results of sensory properties showed that the addition of dry and after removal of bitterness carvilla powder in the mentioned ratios (1:3) gave the highest scores, improving the taste grades of the drinks and were preferred by the consumers.

**Keywords:** Bitter melon, carvilla fruits, nutritional value, antioxidants, phenols, flavonoids, sugars, vitamins

### INTRODUCTION

Bitter melon or bitter gourd (*Momordica charantia* L.), which belongs to the family cucurbitaceae and momordica genus. Bitter melon is used for human consumption all over the world in different forms such as a vegetable and / or medicine (Verma, 2015). Immature fruits of bitter gourd could be prepared in many ways such as frying or cooking as curries, whereas, fruits can be dehydrated, pickled or canned. Also, blanched or soaked in salt water before cooking to reduce the bitter taste (Krawinkel and Keding, 2014). Incorporating bitter foods in commonly consumed food dishes can mask the bitter taste of bitter gourd (Snee *et al.*, 2011).

It is found to be highly nutritive with high levels of protein, minerals and vitamins, (Kubola and Siriamarnpun, 2008). The extract had the highest value of antioxidant activity and that gallic acid was the predominant phenolic compound (Kubola and Siriamarnpun, 2008). Islam *et al.* (2011) determined the chemical composition of four varieties of bitter melon and showed that, the moisture contents ranged from 92.4 to 93.5% and protein contents of 8.4 - 9.8%. Bitter melon is a good source for phenolic compounds, high antioxidant, anti-mutagenic activities and had a biological activity that may be applied in many food systems to enhance food values and special nutritional qualities (Shahidul *et al.*, 2011). Bitter melon phenolic extracts contain natural antioxidant substances and could be used as antioxidant agents in suitable food products (Basch *et al.*, 2003; Zhu *et al.*, 2012). Drewnowski and Gomez-Carneros (2000) found that medicinal value of bitter melon has been attributed to its

high antioxidant properties due to phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, all of which confer a bitter taste. Removal of active bitter components, through a variety of debittering processes as well as selective breeding can result in loss of possible health benefits.

Kubola and Siriamornpun (2011) investigated that, ferrulic and p-hydroxy benzoic acids were most evident in bitter melon pulp. Myricetin was the only flavonoid found in all fractions of fruits. Apigenin was the most predominant flavonoid in pulp but the highest antioxidant activities of pulp extracts were at immature stage. The total phenolic and total flavonoids contents in pulp decreased during the fruit development stage and subsequently displayed lower antioxidant capacity. Horax *et al.* (2010) extracted phenolic compounds from (fleshy portion) of bitter melon harvested at three maturation stages (immature, mature, and ripe) and found that the main phenolic constituents were catechin, gallic acid, gneissic acid, chlorogenic acid, and epicatechin. Sheel and Sruthi (2014) designed to prepare ready-to-serve (RTS) beverages by blending extracts of bitter melon with fruit extracts like mosambi and lemon. These blends had higher values of energy, carbohydrate, vitamin C, protein and iron. The blends had good sensory attributes and shelf life up to a period of 45 days.

Sheng *et al.* (2006) reported that drying method of bitter melon was preferred because of some advantages like it reduced mass (bulk) and lower the cost of packaging and storage. On the other hand, Kuri *et al.* (1991) revealed that bitter gourd develops rubbery texture and become brown in addition to that it also

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loses some of its bitterness, ascorbic acid and chlorophyll during drying. Superfine grinding and lyophilization are helpful for improving extraction of proteins, polysaccharides and other bioactive components such as total phenols, flavonoids and saponins from bitter melon. Bitter melon lyophilized superfine grinding powder had higher total polyphenols of 10.03 mg/g and total flavonoids of 5.27 mg/g compared with its hot air drying superfine grinding powder.

Dandawate *et al.* (2016) revealed that *Momordica charantia*, commonly known for their biological activities used in traditional system of medicines. All parts of the plant, including the fruit, are commonly consumed and cooked with different vegetables. Beverages or drinks are considered to be an excellent medium for the supplementation and nutraceutical compounds for enactment. Beverages from fruits and vegetables are important in human diet. People of all groups consume them to quench the thirst and as health food (Khan and Anderson, 2003).

Therefore, the aim of this work was to determine chemical composition and bioactive compounds. Also a trial to remove the bitter taste from carvilla fruits and utilize its powder for making carvilla drink as an untraditional functional drink.

## MATERIALS AND METHODS

Bitter melon or bitter gourd (*Momordica charantia* L.), was obtained from Faculty of Agriculture, Mansoura University, Mansoura Governorate, Egypt. Black tea (Lipton) imported from Kenia and packed in Egypt by Unilever Mashreq, Tea Company County origin. Spearmint powder was purchased from ISIS company for food processing, Egypt.

All chemicals and reagents used in the present study were of analytical grade and purchased from Al-Gomhouria Company. Chemicals used in HPLC methods were of HPLC grade and purchased from Sigma Company.

## METHODS

### Preparation of bitter melon powder

Fresh mature bitter melon fruits (Long green) were washed with tap water, cut into thin slices with stainless steel knife approximately 0.25 cm and removed seeds then divided as follows:

#### Fresh bitter melon had not any treatment (control).

**Drying of bitter melon (T1):** Fresh bitter melon was dried in a hot air oven at (55°C±5) until reaching to constant weight then grinded using an electrical mill, packed in polyethylene pouches then stored at 4°C for analysis.

**Soaked and dried bitter melon (T2):** Fresh bitter melon was soaked in 5% salt solution at 90°C for 2 min., washed with cold water for 5 min. (to remove the bitterness) as described by Kulkarni *et al.* (2005), then was dried as T1.

### Formulation of bitter melon powder with black tea or spearmint beverage

The powder of bitter melon was used to make eleven samples of drinks from bitter melon (with/without bitterness), black tea and spearmint powder as follows:

Bitter melon powder only (control)

- 1- Bitter melon powder + black tea or spearmint (1+1)
- 2- Bitter melon powder + black tea or spearmint (1+2)
- 3- Bitter melon powder + black tea or spearmint (1+3)
- 4- Bitter melon powder + black tea or spearmint (2+1)
- 5- Bitter melon powder + black tea or spearmint (3+1)

The drinks were prepared according to the methods of RSC (2003).

### Physio-chemical analysis

Moisture, ash, crude protein, crude fiber, total soluble solids (TSS), total acidity contents and pH value were determined according to the methods of the AOAC (2010).

Minerals contents (Ca, Mg, Fe and Zn) were detected using Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380, Japan), whereas, Mn and K were determined using Flame Photometer (model PEP7, England) as described in the AOAC (2010).

Chlorophyll A, B and total carotenoids were determined according to Raghuramulu *et al.* (1983).

Antioxidant activity was determined according to the method described by Allothman *et al.* (2009).

The sugars of fresh and dried bitter melon were fractionated and identified by HPLC (Hewlett Packard, series 1050 county origin) according to the method of Chinnici *et al.* (2005).

Fractionation and identification of phenolic and flavonoid compounds were performed by HPLC according to the methods described by Pascale *et al.* (1999) and Pirjo *et al.* (2000).

Vitamins B complex group of fresh and dried bitter melon were determined by HPLC according to the method of Papadoyannis *et al.* (1997). Vitamin A and E were also determined by HPLC as described by Pyka and Sliwiok (2001), vitamin K by Tomas *et al.* (2007) and vitamin D determined according to Gfimiz-Gracia *et al.* (2000).

### Measurement of potential cytotoxicity by SRB assay

The potential cytotoxic activity of tested samples (fresh bitter melon and dried bitter melon T1 and T2) ethanolic extracts against of human lung carcinoma (A549) cell lines were tested in Department of Oncology, Pharmacology Unit, National Cancer Institute, Cairo, Egypt, using the Sulphodiamine – B assay (SRB) according to the method of Skehan *et al.* (1990).

### Sensory evaluation

Organoleptic parameters, color, taste, odor, texture and overall palatability were evaluated through nine-point scale, where 9 is extremely liked and 1 extremely disliked. Trained panelists were selected from Food Tech. Res. Institute (FTRI), including both male and female members (Lee *et al.* (2003).

### Statistical analysis

The collected data were analyzed using SAS (version 10.0: SAS Institute Inc. Cary, NC) using one way (ANOVA) and Duncan comparisons were tested to signify differences between different samples. A level ( $P < 0.05$ ) was accepted as statistically significant. Data were expressed as means  $\pm$  SD, according to Snedecor and Cochran (1980).

### RESULTS AND DISCUSSION

The chemical composition of bitter melon (*Momordica charantia*) presented in Table (1). Results revealed that fresh bitter melon contained a high level of moisture (92.84%), which decreased after drying to be 8.40 and 8.09% for T1 and T2, respectively. Protein, crude fiber and ash contents were 13.21, 1.47 and 8.54%, respectively, for fresh bitter melon then, recorded, 13.42, 1.42, 8.32% and 13.14, 1.39 and 7.92% for T1 and T2, respectively. The total soluble solids in fresh bitter melon (32.12%) decreased to be 21.62 and 9.57% (dry weight basis) after dried for T1 and T2, respectively. The pH values showed clear increase after drying and soaking in water where (4.64 for fresh, 4.88 for T1 and 5.42 for T2). Total acidity of fresh bitter melon, T1 and T2 were 2.91, 3.07 and 1.81%, respectively. These results are nearest with those obtained by Yuwai *et al.* (1991) who found that the values of moisture, lipids, protein and ash contents in bitter melon were 93.20, 0.78, 18.02 and 8.12%,

respectively. Gopelan *et al.* (1993) found that moisture, carbohydrates, proteins and fibers were 83.20, 10.60, 2.10 and 1.70 g/100g, respectively. Chlorophyll A, B and total carotenoids of fresh bitter melon were found to be relatively higher than that of T1 and T2. These results indicated that drying and soaking with drying were more effective comparing to fresh bitter melon, this previous changes are related to the changes of chlorophyll to pheophorbide and pheophytin (Schwimmer, 1981; Hamed, 1985). Lower chlorophyll content of solar drier was due to the activity of chlorophyllase enzyme that may be responsible for degradation of chlorophyll (Singh and Sagar, 2013). It was also observed that T1 had the highest antioxidant activity (75.40%) while T2 had the lowest value (38.20%), whereas fresh bitter melon had 45.50% antioxidant activity. It is difficult to summarize the evaluation of the antioxidant activity according to the conditions of heat processes. Decreases in phenol content do not lead systematically to a decrease of the antioxidant activity. The degradation products of phenolic compounds can also have an antioxidant activity sometimes higher than the initial phenolic compounds (Buchner *et al.*, 2006; Murakami *et al.*, 2004). Depending on the interactions occurring during heat processes, synergies between antioxidant compounds and the food matrix could occur (Wang *et al.*, 2011). In some cases, the antioxidant capacity of flavonoids in a food matrix is enhanced (Freeman *et al.*, 2010) while in other cases, the antioxidant capacity is reduced (Hidalgo *et al.*, 2010).

**Table (1):** Chemical composition\* of fresh and dried bitter melons

Constituents	Fresh bitter melon	Dried bitter melon	
		T1	T2
Moisture %	92.84 $\pm$ 0.0163	8.40 $\pm$ 0.0216	8.09 $\pm$ 0.0169
Protein %	13.21 $\pm$ 0.0162	13.42 $\pm$ 0.0124	13.14 $\pm$ 0.0081
Crude fibers %	1.47 $\pm$ 0.0094	1.42 $\pm$ 0.0169	1.39 $\pm$ 0.0082
Ash %	8.54 $\pm$ 0.0216	8.32 $\pm$ 0.0094	7.92 $\pm$ 0.0169
Total soluble solids (T.S.S) %	32.12 $\pm$ 0.0161	21.62 $\pm$ 0.0047	9.57 $\pm$ 0.0159
pH value	4.64 $\pm$ 0.0235	4.88 $\pm$ 0.0091	5.42 $\pm$ 0.0166
Total acidity (as citric acid)	2.91 $\pm$ 0.0092	3.07 $\pm$ 0.0094	1.81 $\pm$ 0.0071
Chlorophyll a (mg/100g)	3.45 $\pm$ 0.0309	2.51 $\pm$ 0.0216	1.96 $\pm$ 0.0201
Chlorophyll b (mg/100g)	2.93 $\pm$ 0.0169	2.35 $\pm$ 0.0249	1.78 $\pm$ 0.0141
Total carotenoids (mg/100g)	2.32 $\pm$ 0.0091	2.17 $\pm$ 0.0081	1.46 $\pm$ 0.0082
Antioxidant activity %	45.50 $\pm$ 0.2054	75.40 $\pm$ 0.2943	38.20 $\pm$ 0.1247

Each value represents the average of three determinations  $\pm$  standard deviation

T1: Dried bitter melon with bitterness

T2: Dried bitter melon without bitterness

\* on dry weight basis

### Mineral profile

The mineral contents of fresh bitter melon and its treatments (T1 and T2) are presented in Table (2). Fresh bitter melon contained high levels of K, Ca, Mg, Mn, Fe and Zn. A little decrease was observed in the

aforementioned minerals after dried fresh bitter melon (T1) while clear decrement was observed after soaking and drying (T2) due to the loss of water soluble substances in water during the treatment to remove the bitter taste. Gopelan *et al.* (1993) found that mineral

contents of bitter melon were calcium (23.00), potassium (171.00), iron (2.00), manganese (0.08) and zinc (0.46) as mg/100g, while Kuri *et al.* (1991) reported that bitter melon contained 5.97, 119.92, 3.63 and 137.69 mg/100g (on fresh weight basis) from Fe, Mg, Zn and Ca, respectively, while Bakare *et al.* (2010)

found that the Ca, Mg, K, Fe, Z, Mn contents in bitter melon were 2051.0, 255.0, 413.0, 98.0, 120.0, 156.0 µg/100g, respectively. On the other hand, mineral contents of bitter melon were 171.59, 22.78, 22.74, 0.45 and 72.45 mg/100g from K, Ca, Mn, Fe, Zn, respectively (Krishnendu and Nandini, 2016).

**Table (2):** Minerals contents\* of fresh bitter melon and its treatments

Minerals (mg/100g)	Fresh bitter melon	Dried bitter melon	
		T1	T2
Potassium (K)	1439.22 ± 0.014	1426.11 ± 0.005	426.20 ± 0.016
Magnesium (Mg)	427.21 ± 0.012	413.92 ± 0.017	162.60 ± 0.020
Calcium (Ca)	511.98 ± 0.013	499.12 ± 0.009	212.90 ± 0.021
Manganese (Mn)	0.79 ± 0.004	0.67 ± 0.012	0.60 ± 0.017
Iron ( Fe)	4.32 ± 0.016	4.21 ± 0.016	3.92 ± 0.024
Zinc (Zn)	1.37 ± 0.017	1.30 ± 0.026	1.31 ± 0.022

Each value represents the average of three determinations ± standard deviation

T1: Dried bitter melon with bitterness T2: Dried bitter melon without bitterness \*on dry weight basis

#### Sugar profile of fresh and dried bitter melons

Free sugar contents presented in Table (3), thirteen sugars were identified and fresh bitter melon had high levels of identified sugars, which reduced after drying. Sucrose, arabinose, glucose, tachyose, galacturonic, xylose and glucuronic of fresh bitter melon were 21.84, 19.83, 14.06, 13.39, 11.61, 10.89 and 8.35 mg/100g, respectively. Concerning T1 and T2, drying of T1 resulted in a decrease in all sugars, while soaking then drying for T2 due to the flow of soluble substance in the water and caused a clear decrease in all identified sugars. The decrement could be attributed to the non-enzymatic browning between the free amino acids and reducing sugars (Reynolds, 1965). Therefore, the oven temperatures might have resulted in the loss of identified sugars.

#### Phenolic compounds of fresh and dried bitter melons

Table (4) shows the identification and concentration of 23 phenolic compounds in fresh and drying bitter melon. Pyrogallol was the major phenolic compounds in fresh bitter melon (79.27 mg/100g) followed by benzoic acid (75.99 mg/100), ellagic acid (28.63mg/100g), catechol (20.57 mg/100g), chlorogenic acid (20.31 mg/100g), 3,4,5 methoxycinnamic acid (16.51 mg/100g), ferulic acid (15.88 mg/100) and alpha-coumaric acid (11.24 mg/100g), respectively. These results are agreement with Kubola and Siriamornpun (2011) and Horax *et al.* (2010).

The effect of drying (T1) and soaking then drying (T2) caused a decrement of the identified phenolic compounds. Decreasing and losing of phenolic compounds may be due to heating effect on the transformation of soluble tannins to condensed tannins

(Bate-Smith, 1977), and oxidation phenolic compounds to quinane (Khames, 2004).

**Table (3):** Sugar profile\* of fresh and dried bitter melons

Sugar compounds (mg/100g)	Fresh bitter melon	Dried bitter melon	
		T1	T2
Glucuronic	8.35	7.44	1.43
Stachyose	13.39	11.81	2.54
Galacturonic	11.61	8.69	-
Sucrose	21.84	0.08	0.53
Glucose	14.06	9.58	1.01
Xylose	10.89	7.79	4.29
Maltose	23.25	0.08	0.57
Fructose	16.87	0.76	0.59
Galactose	1.41	0.67	0.22
Mannose	2.64	0.93	0.11
Arabinose	19.83	15.89	1.96
Mannitol	0.25	0.17	0.03
Sorbitol	0.35	0.10	0.02

T1: Dried bitter melon with bitterness

T2: Dried bitter melon without bitterness

\*on dry weight basis

**Table (4):** Phenolic compounds\* of fresh and dried bitter melons

Phenolic compounds (mg/100g)	Fresh bitter melon	Dried bitter melon	
		T1	T2
Gallic acid	1.927	1.667	0.592
Pyrogallol	79.270	39.730	16.625
4-Amino benzoic acid	1.550	0.105	0.054
Protocatechuic acid	11.700	3.901	1.829
Catechin	4.637	0.712	0.148
Chlorogenic acid	20.310	7.892	2.679
Catechol	20.570	6.902	1.898
Epi-catechin	5.810	1.798	1.322
Caffeine	2.960	0.908	0.297
p-OH-benzoic acid	3.128	0.645	0.316
Caffeic acid	1.564	0.491	0.404
Vanillic acid	7.989	2.503	2.056
p-Coumaric acid	5.503	1.942	0.276
Ferulic acid	15.88	8.534	-
Iso-Ferulic acid	2.053	0.845	0.152
Ellagic acid	28.630	19.572	3.202
e -Vanillic acid	23.180	17.410	16.26
Alpha-Coumaric acid	11.240	10.157	3.357
Benzoic acid	75.990	31.635	9.651
3,4,5 Methoxy Cinnamic acid	16.510	9.544	2.588
Coumarin	5.601	1.449	0.479
Salicylic acid	11.480	3.534	-
Cinnamic acid	0.335	0.131	0.029

T1: Dried bitter melon with bitterness

T2: Dried bitter melon without bitterness

\* on dry weight basis

#### Flavonoid compounds of fresh and dried bitter melons

Flavonoid compounds are presented in Table (5). Acacetin was the major flavonoid compound (63.94 mg/100g) in fresh bitter melon followed by quercetrin, rosmarinic, hisperidin, rutin, narengin and hspertin that had 54.46, 20.64, 13.14, 11.05, 8.41 and 5.64 mg/100g, respectively. On the other hand, drying (T1), soaking and drying (T2) led to a clear decrease in the levels of identified flavonoid compounds. These results are nearest with those reported by Kubola and

Siriamornpun (2011). The occurrence of those phenolic and flavonoid compounds in fresh bitter melon may enable to use these fruits as an interesting source of natural antioxidants for the food industry as well as an ingredient in suitable food products. Medicinal benefit of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones and glucosinolates, all of which confer a bitter taste (Snee *et al.*, 2011).

**Table (5):** Flavonoid compounds\* of fresh and dried bitter melons

Flavonoid compounds (mg/100g)	Fresh bitter melon	Dried bitter melon	
		T1	T2
Narengin	8.41	3.36	0.65
Rutin	11.05	7.17	2.25
Hesperidin	13.14	7.25	3.33
Rosmarinic	20.64	16.24	9.84
Quercetrin	54.46	31.02	19.14
Quercetin	0.46	0.29	-
Hispartin	5.64	1.55	0.41
Kaempferol	1.82	0.41	0.72
Rhamnetin	0.62	0.35	0.29
Apigenin	3.70	0.38	0.05
Acacetin	63.94	46.08	-

T1: Dried bitter melon with bitterness

T2: Dried bitter melon without bitterness

\*on dry weight basis

**Vitamins profile of fresh and dried bitter melons**

Table (6) shows that fresh bitter melon fruit had the highest levels of vitamin B3 and B12 (49.65 and 36.66 mg/100g) followed by B6, B2, B9 and B1 which recorded 28.25, 17.91, 17.33 and 12.05 mg/100g, respectively. After drying, a clear decrease was observed in all vitamins B complex were 6.44, 7.96, 37.19, 15.08, 9.26 and 23.36 mg/100 g for vitamin B1, B2, B3, B6, B9 and B12, respectively. All vitamin B complex were reduced after soaking and drying (T2). Concerning vitamins A, D, E, and K (Table 6). Also, drying and soaking with drying treatments caused a pronounced reduction in the previous vitamins. Bitter melon is a powerful nutrient-dense plant composed of a complex array of beneficial compounds. These includes bioactive compounds, vitamins, minerals and antioxidants, which all contribute to their remarkable versatility in treating a wide range of illnesses (Bakare *et al.*, 2010), on the other hand, the fruits contains high amounts of vitamins C, A, E, B1, B2 and B3, as well as vitamin B9 (folate). USDA-ARS (2015) reported that bitter melon content were 0.051, 0.053, 0.041, 0.14 mg/100g and 6, 4.8 µg/100g of B1, B2, B6, E and K, A, respectively.

**Table (6):** Vitamins profile\* of fresh and dried bitter melons

Vitamins (mg/100g)	Fresh bitter melon	Dried bitter melon	
		T1	T2
Thiamine (B1)	12.05	6.44	3.117
Riboflavin (B2)	17.91	7.96	4.514
Nicotinic acid (B3)	49.65	37.19	22.51
Vit. B complex Group	Pyridoxine ( B6)	28.25	15.08
	Folic acid (B9)	17.33	9.26
	Cobalamin (B12)	36.66	23.36
Vit. A	0.319	0.118	0.062
Vit. D	0.035	0.016	0.002
Vit. E	0.088	0.023	0.011
Vit. K	11.25	5.426	0.472

T1: Dried bitter melon with bitterness T2: Dried bitter melon without bitterness \*on dry weight basis

**Cytotoxic activity of fresh and dried bitter melons**

The cytotoxic activity of fresh and dried bitter melon fruit on tumor human lung cells (A549) were shown in Table (7) and Figs (1, 2 and 3). The results showed that the incubation of lung cell (A549) with different level of fresh and dried bitter melon extract (0.00 to 100 µg/ml) for 48 h. at 37°C in atmosphere of 5% CO<sub>2</sub> reduced the viability of this cell.

A high cytotoxic effect of fresh bitter melon extract (49.3 µg/ml) was observed using pharmacological dose which reduced the survival of the human lung carcinoma cell line (A549) to 50% (50% inhibition) followed by dried bitter melon extract (T1

(95 µg/ml). On the other hand, treatment (T2) did not show any cytotoxicity as concluded from the IC<sub>50</sub> values as shown in Table (7) and Fig (3). This may be due to the removing of momoridicine alkaloid and charantin during soaking which responsible for bitterness of bitter melon. Medical activity of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones and glucosinolates, all of which confer a bitter taste (Drewnowski and Gomez-Carneros, 2000). Removal of active bitter components through a variety of debittering processes as well as selective breeding can result in loss of possible health benefits.

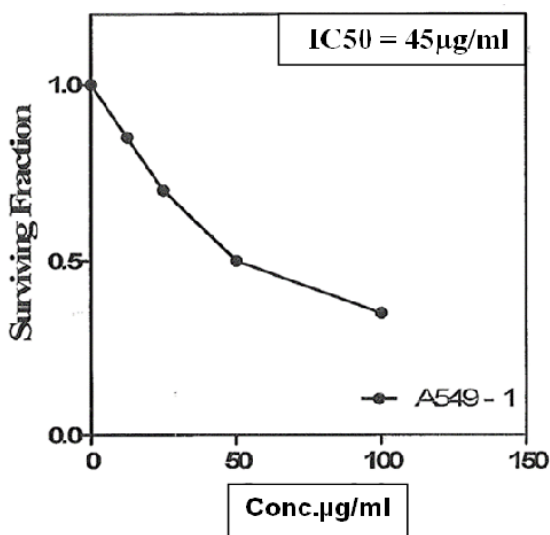
From the previous results, it could be clearly concluded that fresh bitter melon showed a good cytotoxic effect against lung cancer cells (A549) followed by dried bitter melon, due to their phenolic and flavonoid compounds (Table 7 and Figs 1, 2, 3). The diet of bitter melon can be used as a

preventive/therapeutic agent for prostate, breast, colon and adrenocortical cancers (Ray *et al.*, 2010; Ru *et al.*, 2011; Brennan *et al.*, 2012; Kwatra *et al.*, 2013). Therefore, bitter melon might have health benefits for consumers as a potential functional food.

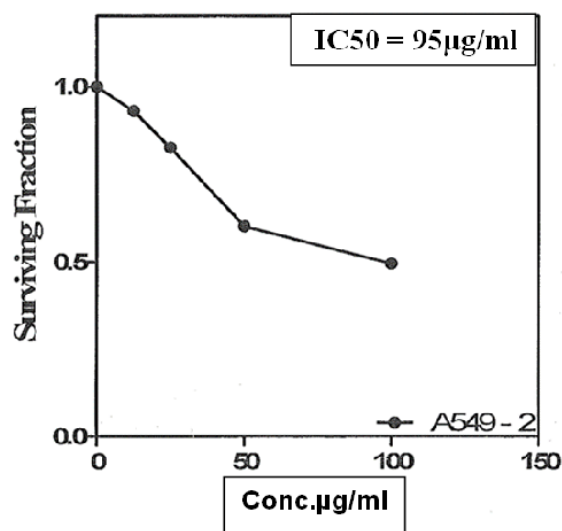
**Table (7):** Cytotoxic activity of fresh and dried bitter melons against human lung cells (A549)

Treatments	Concentration ( $\mu\text{g} / \text{ml}$ )					$\text{IC}_{50}^*$ ( $\mu\text{g}/\text{ml}$ )	
	0	12.5	25	50	100		
Fresh bitter melon	1.000	0.850	0.700	0.500	0.350	49.3	
Dried bitter melon	T1	1.000	0.930	0.825	0.600	0.496	95
	T2	1.000	1.000	0.925	0.710	0.550	-

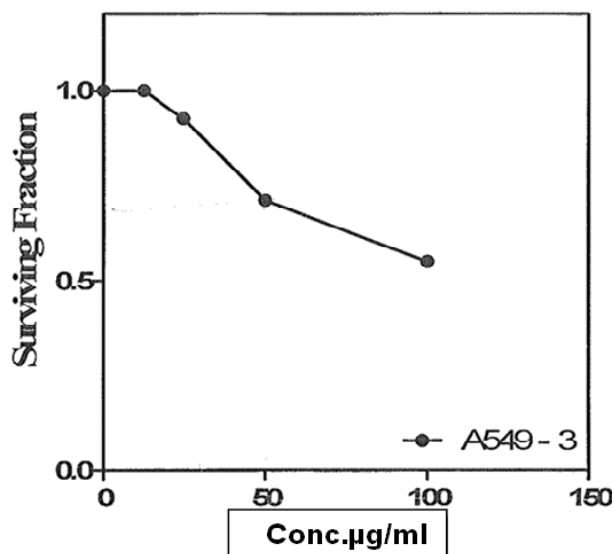
$\text{IC}_{50}$ : Dose, which reduces survival to 50%; T1: Dried bitter melon with bitterness; T2: Dried bitter melon without bitterness



**Fig. (1):** Cytotoxic activity of fresh bitter melon against human lung cells (A549)



**Fig. (2):** Cytotoxic activity of dried bitter melon against human lung cells (A549)



**Fig. (3):** Cytotoxic activity of dried bitter melon after removal of bitterness against human lung cells (A549)

**Sensory evaluation of bitter melon drinks**

The sensory evaluation of bitter melon drinks are shown in Table (8). Drink (BT3) for T1 had the highest mean value of color, taste, odor and overall palatability, while drink (BT5 and control) for T1 had the lowest mean value of all sensory attributes. A significant difference was observed. On the other hand, non significant differences were observed in sensory attributes of bitterness in bitter melon drinks with all percentage of tea additive. Concerning the prepared drinks with spearmint powder, results in Table (8) showed that drink processed from T1 and spearmint (BS3) had the highest values of color, taste, odor and

overall palatability, while drinks (the control and BS5) for T1 had the lowest value of all sensory attributes. Meanwhile, all the drinks prepared from dried bitter melon without bitterness and spearmint appeared accepted by the panelists, while a significant difference was observed between all processed drinks and (BS1 and BS5) in the color, also in the taste of control and BS5. The drinks of bitter melon: black tea or spearmint (BT3) for T1 at the ratio of 1:3 was found to be highly acceptable. The other variations in which the ratios of bitter melon to tea (powder) were increased led to lower scores in parameters like odor and taste.

**Table (8):** Sensory evaluation of dried bitter melon drinks

Treatment No.	Drink (dried bitter melon with black tea)							
	T1 (Dried bitter melon with bitterness)				T2 (Dried bitter melon without bitterness)			
	Color (10)	Taste (10)	Odor (10)	Overall Palatability (10)	Color (10)	Taste (10)	Odor (10)	Overall Palatability (10)
<b>Control</b>	6.7 <sup>e</sup>	5.2 <sup>d</sup>	6.1 <sup>d</sup>	5.9 <sup>c</sup>	7.4 <sup>a</sup>	6.8 <sup>b</sup>	7.1 <sup>a</sup>	6.7 <sup>a</sup>
<b>BT1</b>	7.9 <sup>bc</sup>	6.7 <sup>bc</sup>	6.9 <sup>bc</sup>	7.1 <sup>b</sup>	8.1 <sup>a</sup>	7.8 <sup>a</sup>	7.7 <sup>a</sup>	7.3 <sup>a</sup>
<b>BT2</b>	7.9 <sup>b</sup>	7.3 <sup>ab</sup>	7.6 <sup>ab</sup>	7.8 <sup>a</sup>	8.3 <sup>a</sup>	8.2 <sup>a</sup>	7.8 <sup>a</sup>	7.9 <sup>a</sup>
<b>BT3</b>	8.7 <sup>a</sup>	7.8 <sup>a</sup>	7.8 <sup>a</sup>	8.1 <sup>a</sup>	8.4 <sup>a</sup>	8.4 <sup>a</sup>	8.4 <sup>a</sup>	8.5 <sup>a</sup>
<b>BT4</b>	7.4 <sup>cd</sup>	6.2 <sup>c</sup>	6.5 <sup>cd</sup>	7.0 <sup>b</sup>	8.4 <sup>ab</sup>	7.7 <sup>ab</sup>	8.1 <sup>a</sup>	8.2 <sup>a</sup>
<b>BT5</b>	7.2 <sup>d</sup>	5.1 <sup>d</sup>	6.2 <sup>d</sup>	6.1 <sup>c</sup>	7.9 <sup>ab</sup>	8.2 <sup>a</sup>	7.9 <sup>a</sup>	7.3 <sup>a</sup>
<b>LSD at 0.05</b>	0.576	0.641	0.638	0.630	1.431	1.656	1.559	1.367
Drink (dried bitter melon with spearmint powder)								
<b>Control</b>	6.7 <sup>d</sup>	5.2 <sup>d</sup>	6.1 <sup>d</sup>	5.9 <sup>e</sup>	7.4 <sup>a</sup>	6.8 <sup>b</sup>	7.1 <sup>a</sup>	6.7 <sup>a</sup>
<b>BS1</b>	7.9 <sup>c</sup>	6.8 <sup>b</sup>	7.2 <sup>c</sup>	7.3 <sup>c</sup>	8.4 <sup>ab</sup>	7.7 <sup>ab</sup>	8.1 <sup>a</sup>	8.2 <sup>a</sup>
<b>BS2</b>	8.7 <sup>ab</sup>	7.6 <sup>a</sup>	7.9 <sup>b</sup>	7.9 <sup>b</sup>	8.4 <sup>a</sup>	8.4 <sup>a</sup>	8.4 <sup>a</sup>	8.5 <sup>a</sup>
<b>BS3</b>	9.0 <sup>a</sup>	8.1 <sup>a</sup>	8.5 <sup>a</sup>	8.6 <sup>a</sup>	8.6 <sup>a</sup>	8.6 <sup>a</sup>	8.7 <sup>a</sup>	8.4 <sup>a</sup>
<b>BS4</b>	8.5 <sup>b</sup>	6.3 <sup>bc</sup>	6.8 <sup>c</sup>	7.2 <sup>cd</sup>	8.3 <sup>a</sup>	8.4 <sup>a</sup>	8.2 <sup>a</sup>	7.9 <sup>a</sup>
<b>BS5</b>	7.9 <sup>c</sup>	5.9 <sup>c</sup>	6.7 <sup>cd</sup>	6.7 <sup>d</sup>	7.9 <sup>ab</sup>	7.8 <sup>a</sup>	7.7 <sup>a</sup>	7.7 <sup>a</sup>
<b>LSD at 0.05</b>	0.4	0.674	0.566	0.512	1.431	1.656	1.559	1.367

Value with different letters in the same column are significantly different at P< 0.05

Control: bitter melon powder

BT1: bitter melon powder + black tea (1+1)

BT2: bitter melon powder + black tea (1+2)

BT3: bitter melon powder + black tea (1+3)

BT4: bitter melon powder + black tea (2+1)

BT5: bitter melon powder + black tea (3+1)

BS1: bitter melon powder + spearmint powder (1+1)

BS2: bitter melon powder + spearmint powder (1+2)

BS3: bitter melon powder + spearmint powder (1+3)

BS4: bitter melon powder + spearmint powder (2+1)

BS5: bitter melon powder + spearmint powder (3+1)



## CONCLUSION

The use of fresh and dried bitter melons as excellent sources for natural bioactive components, natural antioxidant and vitamins. This can lead to application in food products and dietary supplements. These natural plant compounds can be beneficial for human health. Results showed that fresh and dried bitter melons were rich in protein, mineral elements and antioxidant contents. Sucrose, arabinose, glucose and stachyose were the major identified sugars in fresh bitter melon, e-vanillic acid, pyrogallol and benzoic acid also quercitrin, rosmarinic acid and hisperidin were the main phenolic and flavonoid compounds, vitamin B12, B3, B6, B9 and k represented high values in fresh bitter melon. Drying led to a clear decrease in all previous compounds. Also, the removal of the bitterness from bitter melon fruit led to a high decrease in all components. The IC<sub>50</sub> of fresh and dried bitter melon extract showed a good cytotoxic effect against lung cancer cells (A549) while dried bitter melon free from bitterness did not show any effect. Therefore, when using bitter melon in feeding one should not remove the bitterness from it.

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## القيمة الغذائية وتحسين قابلية الشمام المر

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الشمام المر (كارفيل) هو خضار شعبي تقليدي طبي في البلاد الاستوائية وشبه الاستوائية. مرارة هذه الثمار غير محبوبة لعدد كبير من الناس، ويعتقد أن تصنيعها في صورة مشروبات تزيد من استساغتها وقبولها. الهدف من هذا العمل هو تقدير التركيب الكيميائي لثمار الكارفيل ومحاولة لإزالة المرارة لاستخدامه كعنصر غذائي في تحضير مشروب الكارفيل مع الشاي وكذلك النعناع. أوضحت النتائج إحتواء ثمرة الكارفيل الطازجة والجافة والمزال منها المرارة على نسب مرتفعة من الرماد والبروتين (٨,٥٤ ، ٨,٣٢ ، ٧,٩٢٪) - (١٣,٢١ ، ١٣,٤٢ ، ١٣,١٤٪) على التوالي. ارتفاع نشاط المواد المضادة للأكسدة في الكارفيل الطازجة و الجافة عن المزال منها المرارة. تعتبر الكارفيل مصدر جيد للعناصر المعدنية خاصة البوتاسيوم، الكالسيوم، المغنسيوم، الحديد والزنك. السكريات مثل المالتوز، السكروز، الأربينوز، الفركتوز، الجلوكوز، الاستاكيوز، الجلاكتورنيك والجلوكورنيك مثلت أعلى نسب في الكارفيل الطازجة بينما إنخفضت بعد التجفيف وإزالة المرارة. يمثل الأي-فانليك، البيروجالول وحمض البنزويك أعلى نسب المركبات الفينولية، بينما الروزمارينيك، الكوارسيتين، اسبيريدين، الاستين هي المركبات الفلافونيدية السائدة والتي انخفضت بعد عملية التجفيف وإزالة المرارة. فيتامينات ب٣، ب٦، ب١٢ وفيتامين ك هي أعلى الفيتامينات الموجودة في ثمار الكارفيل. ب قياس IC<sub>50</sub> للمستخلص الإيثانولي للكارفيل الطازجة والمجففة وجد أن لها نشاط عالي كمضاد لسرطان الرئة بينما لم يظهر أي تأثير للكارفيل المجففة والمزال منها المرارة. أظهرت نتائج الخواص الحسية أن إضافة مسحوق الكارفيل الجاف والمزال منه المرارة بنسبة (٣:١) أعطى أعلى القيم، وحسن خصائص التذوق للمشروبات وكانت مفضله من قبل المستهلكين.