*J. Agric. Sci. Mansoura Univ., 28 (6): 4723 - 4739, 2003*

# CHEMICAL AND BIOLOGICAL EVALUATION OF HUSK TOMATO FRUITS AS ANTIANEMIC AND HYPOCHOLESTEROLEMIC AGENT

**Abd El Ghani, Thoraya; Lobna A.M. Hareedy and Satouta A. El Farra**
**Food Technology Res. Inst., Agric. Res. Center, Giza, Egypt.**

## ABSTRACT

As the husk tomato fruits has a pleasant flavour, yellow colour and which are usually eaten fresh and/or by making preserves as jams, jelly or sauce , therefore the present study was carried out to evaluate the fruits for chemical composition as well as the biological value. The husk tomato fruit was characterized by having high juice content (about 77%) being considered as a rich source of ascorbic acid (120 mg/100g), Oxalic acid 72.21 mg/100 g., total sugars (26.32%) and carotenoids (12.49 mg/100g) on dry weight basis. Meanwhile, husk and peel were characterized with high pectic substances (10.51 and 20.59%). On the other hand, the husk contained carotenoids more than two folds compared to that in the peel (10.43 vis 4.30 mg/100g). Protein content and ether extract were found in similar amounts in seeds (16.27 and 16.09%) dry weight basis. Total carbohydrates and fibers were the main components in all husk tomato fractions. The biological evaluation of dried husk tomato on the haemoglobin content, iron content in serum and liver and its effect of the hypercholestrolemic patients showed a good functional effect with the aforementioned treatments when eaten in the amount of 2.0 gm/day (8.7gm fresh /day). Besides, the results also showed that feeding on 2.0 gm dried husk tomato (8.7gm fresh) resulted in the improved recovery from anemia and also increased the concentration of haemoglobin content, with decreasing the level of cholesterol in serum and liver.

## INTRODUCTION

In Egypt, husk tomato or tomatillo (*Physalis pubescens*, L.) is cultivated through few orchards near the urban cities. In the A.R.E the average production of husk tomato fruits (*Physalis pubescens*, L.) was about 15 tons per feddan (Anon, 2001). The plants are decumbent which produce small round husked fruits of yellow colour and pleasant flavour. The fruits are usually eaten fresh and/or used in making preservers, jams, jellies and sauces. For example, the fruits are used to prepare the green sauces of Mexican cooking Cantwell *et al.* 1992. The fruits are considered as a rich source of vitamins (B and C), minerals (phosphorus and iron) as well as protein, carotene, sugars and organic acids. Pectic substances content in tomatillo fruit (*Physalis ixocarpa*) was similar to that in tomato, but the properties of particular fractions was different (Ostrzycha *et al.*, 1988; Cantwell *et al.*, 1992; Raghava and Nisha, 1992 and Sigata *et al.*, 1994). Moreover, Ostrzycha *et al.* (1988) found tomatillo contained more acids than tomato fruit a showed a specially high citric and malic acid contents. They added that the oxalic acid content was 11-18 mg/100gm in the ripe fruit , and up to 54 mg /100gm in the unripe fruit. The proximate composition, total dietary fiber and pH value of tomatillo (*Physalis pubescens* L.) were determined by Bock *et al.* 1995. They found that the moisture content

averaged about 92% and also tomatillo contained 11% protein, 18% fat, 13% ash and 5% total dietary fiber, carbohydrates (CHO) content were calculated by difference resulting in an average adjusted (CHO) (excluding dietary fiber) was 53% on dry matter basis (DMB) and 4% as consumed basis (ACB) : total CHO (including dietary fiber) was 58 and 4.8%, respectively.

Abou-Gharbia and Abou-Tour (2001) found that the pulp of husk tomato fruit (*Physalis pruinose*) has yellowish or orange colour mixed with very light green colour with a yield of 65% and having light sweet taste with acidic nature (pH value 3.78 and total titratable acidity of 1.22% as citric acid (on fresh wt. basis), also containing moderate amounts of ascorbic acid (35.5 mg/100 gm fresh weight basis), non-reducing sugars (70.8% of the total sugars), having 80.71% moisture content, 5.65% total ash, 5.87% crude fiber, 5.7% ether extract (on dry basis), and 13% total soluble solids (T.S.S.). They also mentioned that the pulp could be considered as a good source of potassium, phosphorus and magnesium whereas being limited in sodium. It is well known that minerals such as iron and zinc play an important role in human metabolism. The iron is essential for the synthesis of haemoglobin and in turn for gas exchange (Goodhart and Shils, 1983). Vitaminolides, isolated from husk tomato, showed anti-inflammatory activity against induced inflammation in rats and mice (Syrov *et al.*, 1989). The seeds of husk tomato fruit can be considered as a new source of edible oil in addition to its high content of carbohydrates and protein which can be used in animal feeding (Abd El-Ghani and El-Farra, 1994).

Due to the shortage of knowledge and experience about husk tomato in Egypt, the present study was carried out to investigate the chemical composition of each part of the fruit as well as the biological evaluation of husk tomato fruits.

## MATERIALS AND METHODS

**Materials :**

Fresh husk tomato fruits (*Physalis pubescens*, L.) which is popular in some localities of Egypt were obtained from the local market at Giza, Egypt.

Sixty six male albino rats (more than 100 gm) were obtained from the Opthalmology Res. Inst., Giza, Egypt.

**Methods :**

**Samples preparation :**

After washing of husk tomato fruits, the following scheme Fig. (1) was conducted for the separation of each part of the fruit.

**Chemical analysis :**

The moisture content, ash, crude fiber, total protein, ether extract, ascorbic acid, alcohol insoluble solids, total acidity and pH value were determined according to the methods outlined in A.O.A.C (1990). The method described by Umiel and Gableman (1971) was used for the determination of carotenoid pigments.

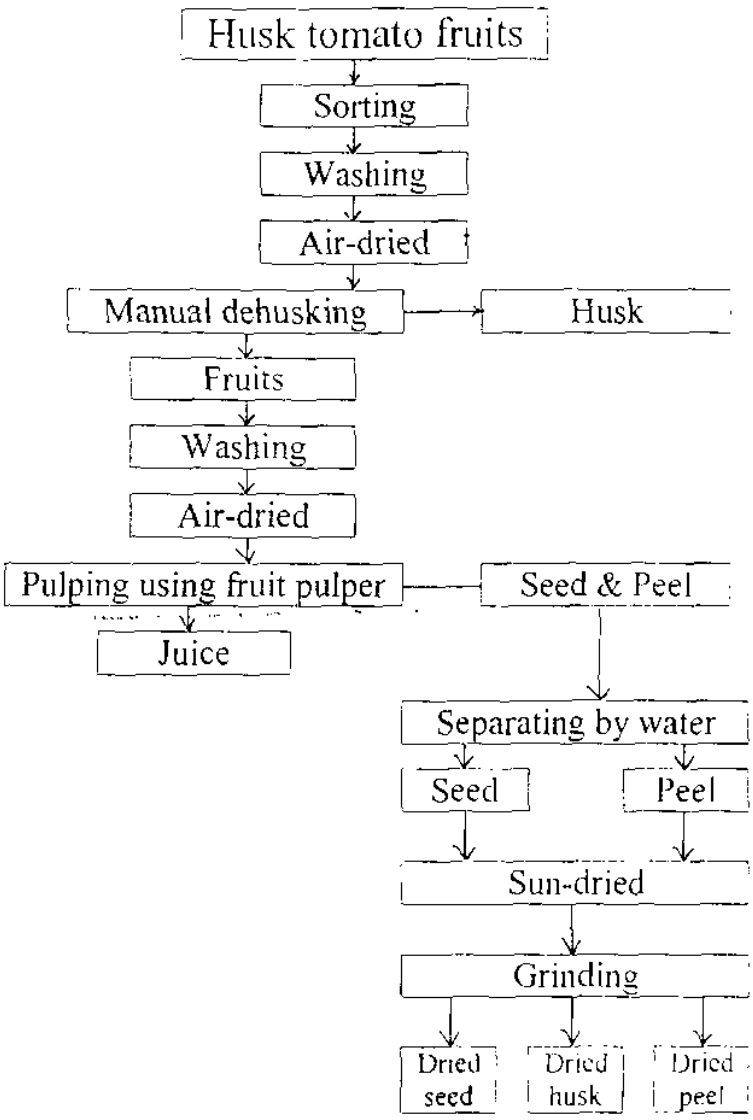


**Fig. (1) : Flow sheet for preparing each part of husk tomato fruits**

Pectic substances were determined according to the method described by Rouse and Atkins (1955). Total soluble solids (T.S.S.) were determined by Carl Zeiss refractometer at 20°C as described by Ranganna (1977). Reducing and total sugars were determined according to the method described by Somogyi and Nilson (1952), while non-reducing sugars were calculated by difference. Oxalic acid determination was carried out according to the method of A.O.A.C (1990) and also by colorimetric determination as well as by the HPLC series 1100 technique. Mineral content representing calcium, potassium, sodium, copper, magnesium, manganese, zinc and iron were determined after ashing using Atomic Absorption (Pye Unicam Absorption spectrophotometer sp. 1900) as described by Rawe (1973).

**Biological evaluation :**

Sixty six male albino rats (more than 100 gm) were fed in the animal house of the Opthalmology Res. Inst., Giza. All animals were kept under normal healthy conditions and fed on basal diet for 10 days. The basal diet constituents are shown in Table (1), water and diet provided ad-libtium. After feeding the basal diet for 10 days, rats were divided randomly into 3 main groups (Fig. 2) with 11 subgroups (n = 6) according to the following scheme :

**Table (1): Composition of basal diet (control), high fat diet and anemic diet (g/Kg)**

| Ingredients | Basal diet control (g) | High fat diet (B) (g) | Anemic diet (free iron) (A) (g) |
|---|---|---|---|
| Casein | 250 | 250 | 250 |
| Corn starch | 545 | 375 | 545 |
| Sucrose | 50 | 50 | 50 |
| Corn oil | 60 | 60 | 60 |
| Cholesterol | --- | 10 | --- |
| Beef tallow | --- | 160 | --- |
| Cellulose | 50 | 50 | 50 |
| Vitamin mixture (C)(x) | 10 | 10 | 10 |
| Mineral mixture (D) | 35 | 35 | 35 (free iron) |

**(I) : Anemic diet free from iron**

**(II) : Basal diet or high fat diet containing iron as $FeSO_4.5H_2O$ (27 g/Kg of mixture).**

**(III) : Vitamin mix. g/Kg diet were Thiamin, 0.500; Riboflavin, 1.00; Pyridoxine hydrochloride, 0.40; Calcium pantothenate, 4.00; Inositol, 25.0; P. amino benzoic acid, 10.0; Biotin, 0.02; Niacin, 4.0; Folic acid, 0.20 and vitamin B12, 0.002. (Venkatarman *et al.*, 1979).**

**(IV) : Mineral mixture g/Kg diet were $CaCO_3$, 207.14; $CaHPO_4$, 322.85; $NaHPO_4$, 171.42; HCl, 225.47; $MgSO_4$, 65.71; $MnSO_4.H_2O$, 4.40; $ZnCO_3$, 1.51; $CuSO_4$, 1.42; $KIO_3$, 0.08 (Hegsted *et al.*, 1941).**

**(x) : Choline chloride (200 g/Kg) was dissolved in a small amount of ethanol and added slowly to the mixture.**

Group 1 : The control group fed on basal diet only.

Group 2 : Fed on anemic diet which was divided into 5 subgroups as follows :

i) Anemic diet

ii) Anemic diet + 2.0 gm husk tomato

iii) Anemic diet + (RDA*) of Fe from husk tomato

iv) Control diet + 2.0 gm husk tomato

v) Control diet + RDA of Fe from husk tomato

* = Recommended Daily Allowances

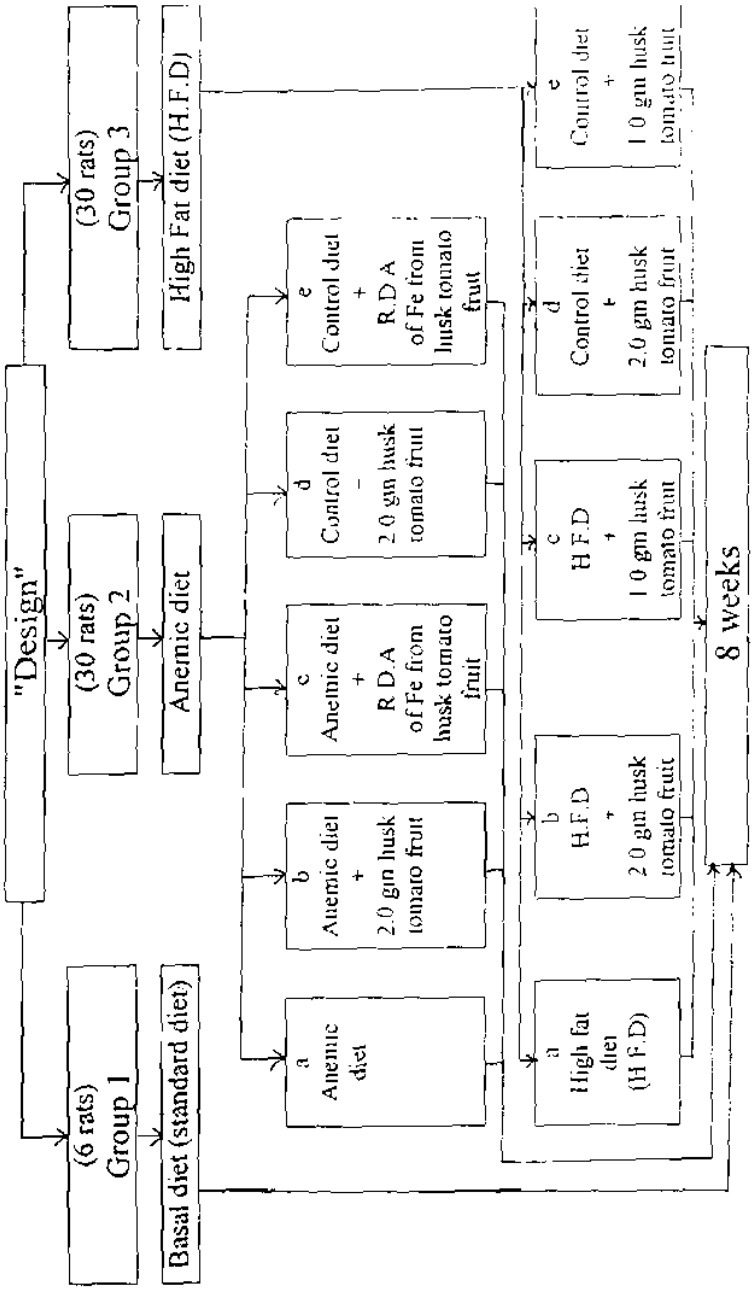


Fig. (2) : Design of the experimental rats fed on anemic diet, standard diet and high fat diet

Group 3 : Fed on high fat diet which was divided into 5 subgroups as follows :

i) High fat diet
ii) High fat diet + 2.0 gm husk tomato
iii) High fat diet + 1.0 gm husk tomato
iv) Control diet + 2.0 gm husk tomato
v) Control diet + 1.0 gm husk tomato.

**Biological determination :**

During the experiment (8 weeks), rats were kept separately in well aerated cages (stainless steel). The body weight was recorded every 3 days. At the end of the experiment (8 weeks), rats were fastened overnight and anathesized using diethyl ether and the blood was collected from the orbital venous plexuses by capillary tube into a clean centrifuge tube. To prevent blood clotting, a drop of heparin was added. Liver, kidney, spleen, heart and lungs were separated by careful dissection, weighed and kept in saline solution at -10°C till analysis. Blood hemoglobin, iron and serum total cholesterol were determined according to the method described by Henry (1964), Farinati *et al.* 1995 and Thomas *and Diagnose.*, 1992, respectively.

**Statistical analysis :**

The collected data of biological evaluation were statistically analyzed by the least significant differences (L.S.D), at the 5.0% level of probability according to Snedecor and Conchran procedure (1980).

## RESULTS AND DISCUSSION

Data given in Table (2) show the components of husk tomato fruits as extracted juice, husk, peel, seed and dehydrated products and their percentages. From the obtained results, it could be noticed that the percentage of extracted juice, husk, peel and seeds in the fresh fruits were 77%, 9%, 3.8% and 10.2%, respectively. On the other hand, the husk, peel and seeds . amounted to 5.83%. 0.83% and 5.67%, respectively, as dehydrated products. From these data the juice of fruit was constituted as the main component. The data given in Table (3) show chemical composition of fresh husk tomato juice (on dry weight basis). The results reveal that the juice is characterized by high total acidity with acid value of 9.9 and pH value of 4.08. It is also being a rich source of total sugars (26.32%) with non-reducing sugars of 24.6%. Ascorbic acid of juice showed a high value being 120.97 mg/100 gm which is considered a good source of the vitamin. Total carotenoids content was 12.49% mg/100 gm which is considered besides the presence of ascorbic acid as a good antioxidants. Oxalic acid content in the fresh sample of husk tomato was 72.21 mg/100 g dry weight basis and also 1.375% from total organic acid found in the husk tomato fruits fig (3). The presence of pectic substances at the amount of 0.67% (as total) reflect the viscous state of the juice beside the total soluble solids (10.27%). On the other hand, total pectic substances showed its maximum value (20.59%) in peel followed by husk (10.51%) while seeds were poor in pectic substances (3.41%).

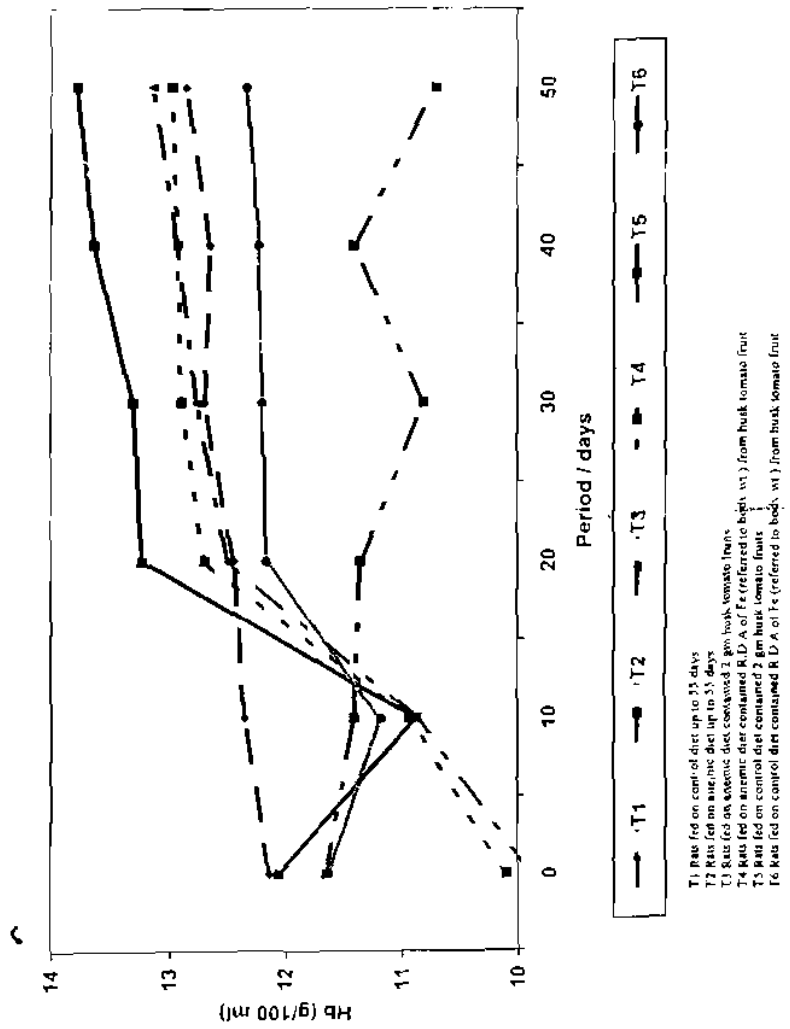


Fig. (3) : Blood haemoglobin levels (Hb) (g/100 ml) of depleted rats as well as after feeding with husk tomato fruits

This reflects the importance of the husk as a good source of pectic substances which varied according to its solubility (water, ammonium oxalate, or sodium hydroxide). These results are in accordance with those of Ostrzycka *et al.* 1988; Cantwell *et al.* 1992 and Abou-Gharbia and Abou-Tour (2001) who found that pectin content was about 1.1% being similar to tomato pectin. Concerning carotenoids, husk characterized with highest value (10.43 mg/100 gm) followed by peel (4.30 mg/100 gm) while seeds are poor in carotenoids (0.30 mg/100 gm).

**Table (2): Components percentage of fresh and dehydrated husk tomato fruits.**

| Components | Percentage (%) |
|---|---|
| **A: Fresh fruits** | |
| Whole husk tomato fruit | 100 |
| Juice | 77 |
| Husk | 9.0 |
| Peel | 3.8 |
| Seeds | 10.2 |
| **B: Dehydrated products** | |
| Husk | 5.73 |
| Peel | 0.83 |
| Seeds | 5.67 |

**Results are mean values of three determinations.**

**Table (3) : Chemical composition of husk tomato fruits fractions (on dry weight basis)**

| Chemical constituents | Juice | Husk | Peel | Seed |
|---|---|---|---|---|
| Total soluble solids (T.S.S) % | 10.27 | --- | --- | --- |
| Total acidity (as citric acid)% | 9.90 | --- | --- | --- |
| pH value | 4.08 | --- | --- | --- |
| Alcohol insoluble solids (A.I.S)% | 11.46 | --- | --- | --- |
| Ascorbic acid (mg/100 gm) | 120.97 | --- | --- | --- |
| Oxalic acid (mg/100gm) | 72.21 | --- | --- | --- |
| Reducing sugars % | 1.73 | 0.11 | 0.16 | --- |
| Non-reducing sugars % | 24.59 | 0.78 | 0.78 | 0.83 |
| Total sugars % | 26.32 | 0.89 | 0.94 | 0.83 |
| **Pectic fractions %** | | | | |
| Water-soluble pectin % | 0.24 | 1.23 | 0.93 | 0.82 |
| Ammonium oxalate-soluble pectin % | 0.21 | 4.87 | 9.38 | 1.69 |
| Sodium hydroxide-soluble pectin % | 0.22 | 4.41 | 10.28 | 0.90 |
| Total pectic substances % | 0.67 | 10.51 | 20.59 | 3.41 |
| Carotenoids (mg/100 gm) | 12.49 | 10.43 | 4.30 | 0.30 |

**Results are mean values of three determinations.**

Results in Table (4), show chemical composition of fresh and dehydrated husk tomato products. The seeds contained the highest protein and fibers (16.27 and 46.24%, respectively) followed by peel (8.94 and 38.64%, respectively), while the husk showed a lowest value for protein (1.63%) while similar as that of peel for fiber content (38.37%). Seeds was characterized by the highest ether extract (16.09%) while husk and peel had the comparable value 5.89 and 5.15%, respectively. As for ash content, it amounted to 7.54, 9.58, 2.73, and 2.62% in the juice, husk, peel and seeds, respectively. The juice contained the highest total carbohydrates content (86.60%), while the seeds contained the lowest ones (65.02%). The presence of high amounts of total carbohydrates in juice may be due to the highest amounts of total soluble sugars, soluble pectic substances and other related substances. Meanwhile the high amounts in husk, peel and seeds may be due to the hydrolysate or macromolecules of carbohydrates to small ones. As for moisture content, it ranged between 40.56 to 87.27% for husk, seed, peel and juice. The lowest value in dried products was found in the husk (6.93%). These results are in accordance with those found by Abd El-Ghani and El-Farra (1994) and Bock *et al.* (1995).

**Table (4): Proximate chemical composition of husk tomato fruit fractions (on dry weight basis)**

| Chemical constituents | Juice | Husk | Peel | Seed |
|---|---|---|---|---|
| Crude protein (N × 6.25) | 5.66 | 1.63 | 8.94 | 16.27 |
| Ether extract % | 0.20 | 5.89 | 5.15 | 16.09 |
| Ash % | 7.54 | 9.58 | 2.73 | 2.62 |
| Total carbohydrates (by difference) % | 86.60 | 82.90 | 83.18 | 65.02 |
| Crude fibers % | --- | 38.37 | 38.64 | 46.24 |
| Moisture content * % | 87.27 | 40.56 | 79.89 | 49.62 |
| Moisture content xx % | --- | 6.93 | 7.49 | 7.69 |

***: Moisture content of fresh husk tomato fruits**
**xx : Moisture content in the sun-dried husk tomato by-products.**
**Results are mean values of three determinations.**

From the data in Table (5), it could be noticed that the juice extracted from husk tomato fruits and peel contained highest amounts of potassium being 2752.34 and 1039.71 mg/100 gm, respectively.While the husk and seed contained 939.48 and 485.06 mg/100 gm, respectively. Sodium and magnesium ranged between 33.46 to 168.0 and 92.57 to 137.08 mg/100 gm in husk tomato fruits either extracted juice and/or seed besides both husk and peel contained moderate amounts of calcium. As for micro elements content, manganese gave the lowest value, as it was 0.3 mg/100 gm. Concerning iron, copper and zinc, it ranged between 5.59 to 43.88; 21.42 to 38.19 and 2.10 to 4.80 mg/100 gm respectively. The obtained data reveal that the husk tomato and its fractions were rich in K, Na, Ca and Mg. Meanwhile, Fe content was the highest in husk (43.88 mg/100 gm) followed by peel (9.45 mg/100 gm), seeds (7.49 mg/100 gm) and juice (5.59 mg/100 gm).

**Table (5) :Mineral content of husk tomato fruits (on dry weight basis)**

| Elements * (mg/100 gm) | Juice | Husk | Peel | Seed |
|---|---|---|---|---|
| K | 2752.34 | 939.48 | 1039.71 | 485.06 |
| Ca | 54.452 | 510.26 | 361.95 | 49.76 |
| Mg | 112.38 | 137.08 | 128.43 | 92.57 |
| Na | 168.0 | 163.34 | 155.77 | 33.46 |
| Fe | 5.59 | 43.88 | 9.45 | 7.49 |
| Zn | 0.94 | 1.39 | 4.80 | 2.10 |
| Cu | 23.04 | 35.64 | 38.19 | 21.42 |
| Mn | N.D | 0.3 | N.D ** | 0.3 |

* : Average of duplicate analyses
** N.D : Not Detected.

**Biological evaluation of husk tomato fruits** :

The data given in Table (6) indicate non significant differences in body weight gain as a result of feeding control diet, anemic and high fat diet which amounted to 57.5, 60.0 and 62.5 gm, respectively. Feeding on anemic diet blended with dehydrated husk tomato (2.0 gm or Recommended Daily Allowances (RDA) showed non significant differences (41.67 or 45.0 gm) as well as that of the control diet mixed with 2.0 gm husk tomato (60.0 gm).

Concerning high fat diet, the data reveal that the addition of husk tomato either at 1.0 gm or 2.0 gm increased the body weight gain but in non-significantly value. The increment in body weight gain due to high fat diet may be due to the fat storage in the adipose tissues. Meanwhile, the decrement in body weight gain as a result of anemic diet may be due to the iron deficiency. These results are in accordance with those obtained by Hurrell *et al.* 1989 and Williams (1990) who reported that the bioavailability and chemical reactivity of reduced iron depend on the particle size as the smaller particles were better and had good bioavailability.

Table (7) shows the mean weight of rats organs (gm) as a result of depletion and repletion of iron also due to hypercholesterolemia. The organs under study were liver, kidney, spleen, heart and lung. The liver weight ranged from 5.58 to 6.83 gm which showed significant differences between group of rats fed on high fat diet plus 2.0 gm of husk tomato fruits (T5A) only and other treatments, while other treatments showed non-significant differences (L.S.D 1.089). Concerning kidney, a significant difference was found between group of rats fed on control diet, anemic treatments except that of (group of rats fed on control diet plus Recommended Daily Allowances (R.D.A) from husk tomato fruits) (T3D), group of rats fed on high fat diet plus 2.0 gm husk tomato fruits) (T5A), (group of rats fed on high fat diet plus 1.0 gm of husk tomato fruit) (T5B). On the other hand, anemic control resulted in non significant differences between the subgroups. Similar trend of the hypocholesterolemia treatments was found as that of anemic ones except that of T5D which resulted in low significant differences than that other subgroups. Regarding spleen, anemic treatment showed the lowest significant differences followed by T3D while other treatments resulted in non-significant differences.

**Table (6) : Effect of feeding with husk tomato fruits on the body weight of rats ***

| Treatments | Food Intake | Initial B.W** | Final B.W | B.W Gain | Daily B.W Increase |
|---|---|---|---|---|---|
| T1 | 11.66 | 140.0 $^{cd}$ | 197.5 $^{bcd}$ | 57.5 $^{cde}$ | 1.15 $^{cde}$ |
| T2 | 12.91 | 155.0 $^{bc}$ | 215.0 $^{abc}$ | 60.0 $^{bcde}$ | 1.20 $^{bcde}$ |
| T3A | 16.25 | 195.0 $^{a}$ | 236.67 $^{a}$ | 41.67 $^{e}$ | 0.833 $^{e}$ |
| T3B | 15.25 | 183.33 $^{ab}$ | 228.33 $^{ab}$ | 45.0 $^{de}$ | 0.90 $^{de}$ |
| T3C | 15.66 | 188.33 $^{a}$ | 248.33 $^{a}$ | 60.0 $^{bcde}$ | 1.20 $^{bcde}$ |
| T3D | 11.66 | 140.0 $^{cd}$ | 193.33 $^{bcd}$ | 53.33 $^{cde}$ | 1.067 $^{bcde}$ |
| T4 | 8.92 | 107.5 $^{de}$ | 170.0 $^{d}$ | 62.5 $^{bcde}$ | 1.25 $^{bcde}$ |
| T5A | 10.83 | 130.0 $^{cde}$ | 221.67 $^{abc}$ | 91.67 $^{abc}$ | 1.833 $^{abc}$ |
| T5B | 9.83 | 118.33 $^{de}$ | 198.33 $^{bcd}$ | 80.0 $^{abcd}$ | 1.60 $^{abcd}$ |
| T5C | 9.42 | 113.33 $^{de}$ | 190.0 $^{cd}$ | 76.67 $^{abcde}$ | 1.533 $^{abcde}$ |
| T5D | 8.50 | 102.67 $^{e}$ | 198.33 $^{bcd}$ | 95.67 $^{ab}$ | 1.913 $^{ab}$ |
| L.S.D 0.05. | | 30.726 | 31.801 | 32.671 | 0.653 |

T1 : Group of rats fed on control diet.
T2 : Group of rats fed on anemic diet
T3A : Group of rats fed on anemic diet plus 2.0 gm of husk tomato fruit
T3B : Group of rats fed on anemic diet plus R.D.A of Fe from husk tomato fruit
T3C : Group of rats fed on control diet plus 2.0 gm of husk tomato fruit
T3D : Group of rats fed on control diet plus R.D.A of Fe from husk tomato fruit
T4 : Group of rats fed on high fat diet
T5A : Group of rats fed on high fat diet plus 2.0 gm of husk tomato fruit
T5B : Group of rats fed on high fat diet plus R.D.A of Fe from husk tomato fruit
T5C : Group of rats fed on control diet plus 2.0 gm of husk tomato fruit
T5D : Group of rats fed on control diet plus 1.0 gm of husk tomato fruit
* Values not sharing the same superscript are significantly different
** Body weight

**Table (7) : Means of organ weight of rats (in gram) by different feeding *treatments***

| Treatments. | Liver | Kidney | Spleen | Heart | Lung |
|---|---|---|---|---|---|
| T1 | 6.39 $^{abc}$ | 1.80 $^{a}$ | 0.76 $^{ab}$ | 0.66 $^{abc}$ | 1.26 $^{a}$ |
| T2 | 6.10 $^{abc}$ | 1.24 $^{c}$ | 0.38 $^{e}$ | 0.64 $^{abc}$ | 1.06 $^{a}$ |
| T3A | 6.54 $^{abc}$ | 1.39 $^{bc}$ | 0.59 $^{bcd}$ | 0.65 $^{abc}$ | 1.25 $^{a}$ |
| T3B | 5.58 $^{bc}$ | 1.41 $^{bc}$ | 0.48 $^{cde}$ | 0.63 $^{bc}$ | 1.37 $^{a}$ |
| T3C | 6.53 $^{abc}$ | 1.47 $^{bc}$ | 0.62 $^{bc}$ | 0.71 $^{ab}$ | 1.57 $^{a}$ |
| T3D | 6.13 $^{abc}$ | 1.48 $^{abc}$ | 0.43 $^{de}$ | 0.64 $^{abc}$ | 1.49 $^{a}$ |
| T4 | 5.68 $^{c}$ | 1.37 $^{c}$ | 0.60 $^{bc}$ | 0.49 $^{d}$ | 1.24 $^{a}$ |
| T5A | 6.83 $^{ab}$ | 1.56 $^{abc}$ | 0.54 $^{cde}$ | 0.67 $^{abc}$ | 1.32 $^{a}$ |
| T5B | 6.56 $^{abc}$ | 1.56 $^{abc}$ | 0.62 $^{bc}$ | 0.60 $^{c}$ | 1.30 $^{a}$ |
| T5C | 5.99 $^{abc}$ | 1.29 $^{c}$ | 0.51 $^{cde}$ | 0.59 $^{c}$ | 1.39 $^{a}$ |
| T5D | 6.54 $^{abc}$ | 0.94 $^{d}$ | 0.50 $^{cde}$ | 0.61 $^{c}$ | 1.19 $^{a}$ |
| L.S.D 0.05 | 1.089 | 0.289 | 0.148 | 0.087 | 0.484 |

Values not sharing the same superscript are significantly different

Concerning the heart weight (group of rats fed on high fat diet), (T4), (group of rats fed on high fat diet plus 1.0 gm of husk tomato fruit) (T5B), T5C and T5D showed a lowest significant differences compared to the other treatments while the later 3 treatments resulted in non-significant differences between them. It could be noticed from the data, that lungs showed an

almost constant weight and in paralleled there were non-significant differences due to the treatments.From the obtained data, it could be concluded that iron depletion, repletion, hypercholesterolemia treatments with husk tomato affected the organs weight. The data were in line with that obtained by Rahman *et al.* 1995 and Roodenburg *et al.* 1995 who stated that weights of liver, spleen, heart, kidney and lungs were significantly high in groups fed with iron, vitamin A than those lacking vitamin A or any source of iron in their diets.

Table (8) show the effect of different diet treatments on the hemoglobin content in the experimental rats. The data reveal that the different diet affected hemoglobin content at the adaptation period. There were non-significant differences after 10 days of the treatment beginning (adaptation period) except that of treatments 5 (rats fed on control diet contained 2.0 gm husk tomato fruits) and treatment 6 (rats fed on control diet contained RDA referred by body weight "husk tomato fruit") of which a significant decrease was found during the adaptation period.

During repletion period, it could be observed that a significant increase was found in hemoglobin content as a result of period of rats fed control diet but not significant as a result of diet treatment compared to the adaptation period. Meanwhile, treatment 2 (rats fed on anemic diet up to 55 days) resulted in a significant decrease due to treatment and period. On the other hand, a significant increase was found due to the period and treatments of the group fed on treatment 3 (anemic diet contained 2.0 gram husk tomato fruit), treatment 4 (anemic diet contained RDA referred by body weight husk tomato fruits), treatment 5 (control diet contained 2.0 gram husk tomato fruit) and treatment 6 (control diet contained RDA referred by body weight husk tomato fruit). It could be concluded that husk tomato contained iron in a form which to be available to consumption and metabolized in the body.

In this respect, it could be concluded that the highest availability of the iron may be due to its organic formula and also husk tomato fruit improved the recovery from anemia based on the hemoglobin concentration in iron deficient rats. The obtained data are in the line with those of Ranhorta *et al.* 1973; Fairweather-Tait and Southan (1989) and Ostrzycka *et al.* (1988) who found that the content of iron was higher in husk tomato fruit, and also dietary iron induces Hb regeneration at a satisfactory rate and permits a reasonably accurate assessment of relative iron availabilities.

From Table (9) the iron concentration in the rats liver ranged from 8.02 to 9.67 mg/100gm weight tissue for the repleted rats which is almost the same as the control. Meanwhile, the depleted (fed anemic diet) rats showed a liver contain about one tenth as that of control and repleted rats. These figures ensure our predication concerning the availability of iron in organic form. The data agree with those obtained by Fashakin and Oladimeji (1986) and Van Houwelingen *et al.* (1993) who reported that iron concentration in different tissues of rats increased as a result of feeding with dietary vitamin A or vitamin C and iron. In this respect, Jankiewicz (1989) found that vitamin C content ranged from 7 to 20 mg/100 gm (fresh weight) in husk tomato and he also added that no harmful components were found.

**Table (8) : Effect of feeding husk tomato fruit on haemoglobin content in rats**

| Treatments | Haemoglobin g/100 ml | | Haemoglobin during repletion period | | | | L.S.D 0.05 |
|---|---|---|---|---|---|---|---|
| | Zero | After Depletion Period | 20 days | 30 days | 40 days | 55 days | |
| 1 | $12.15^{Da}$ | $12.35^{Ca}$ | $12.45^{Cc}$ | $12.7^{ABb}$ | $12.65^{Bc}$ | $12.85^{AC}$ | 0.173 |
| 2 | $11.65^{Ab}$ | $11.4^{Ab}$ | $11.35^{Ae}$ | $10.8^{Bd}$ | $10.8^{Bd}$ | $10.7^{Be}$ | 0.356 |
| 3 | $9.87^{Fd}$ | $10.87^{Ed}$ | $12.5^{Dbc}$ | $12.77^{Cb}$ | $12.93^{Bb}$ | $13.13^{Ab}$ | 0.157 |
| 4 | $10.1^{Dc}$ | $10.93^{Cd}$ | $12.7^{Bb}$ | $12.9^{Ab}$ | $12.93^{Ab}$ | $12.97^{Abc}$ | 0.192 |
| 5 | $12.07^{Ca}$ | $10.87^{Dd}$ | $13.23^{Ba}$ | $13.3^{Ba}$ | $13.63^{Aa}$ | $13.77^{Aa}$ | 0.248 |
| 6 | $11.63^{Bb}$ | $11.17^{Cd}$ | $12.17^{Ad}$ | $12.27^{Ac}$ | $12.23^{Ad}$ | $12.33^{Ad}$ | 0.218 |
| L.S.D 0.05 | 0.129 | 0.209 | 0.233 | 0.266 | 0.238 | 0.224 | |

Capital letters for periods (days)
*Small letters for treatments (1-6)*
Means with the same letter are not significantly different
1 Rats fed on control diet up to 55 days
2 Rats fed on anemic diet up to 55 days
3 Rats fed on anemic diet contained 2 gm husk tomato fruits
4 Rats fed on ansmic diet contained R.D.A of Fe (referred to body wt.) from husk tomato fruit.
5 Rats fed on control diet contained 2 gm husk tomato fruits
6 Rats fed on control diet contained R.D.A of Fe (referred to body wt.) from husk tomato fruit.

**Table (9): Iron concentration (mg/100g wet tissue) in liver of rats fed with *husk tomato fruit compared to the control samples***

| Samples No. | Iron concentration (mg/100g) |
|---|---|
| Rats fed on control diet | 8.97 |
| Rats fed on anemic diet | 1.581 |
| Rats fed on anemic diet contained 2.0 g husk tomato | 9.03 |
| Rats fed on anemic diet contained R.D.A from husk tomato | 9.34 |
| Rats fed on control diet contained 2.0 g husk tomato | 9.67 |
| Rats fed on control diet contained R.D.A from husk tomato | 8.02 |

Data from Table (10) show the concentration of iron from husk tomato fruit added to the diet according to the (Recommended Daily Allowances) (RDA) which increased in proportionally state with the increasing of body weight (daily). The data reveal also that the different diet affected RDA of iron from husk tomato fruits content at the repletion period up to 8 weeks.

Table (11) show the effect of feeding husk tomato on serum cholesterol of the experimental animals. After adaptation period (fed on high fat diet for 10 days to obtain hypercholestrolemic rats), cholesterol content increased significantly due to adaptation periods of feeding treatments.

**Table (10): Recommended Daily Allowances of Iron from dehydrated husk tomato fruit**

| Treatments | Rats weight (Daily) | Diet intake (Daily) | Recommended Daily Allowances (R.D.A) (referred by body weight) | Iron from dried husk tomato intake (Daily) |
|---|---|---|---|---|
| T3A | 230 | 19.09 | 0.518 | 1.07 |
| | 225 | 18.68 | 0.506 | 1.04 |
| | 185 | 15.35 | 0.416 | 0.86 |
| T3B | 220 | 18.26 | 0.495 | 1.02 |
| | 215 | 17.85 | 0.484 | 0.99 |
| | 190 | 15.77 | 0.428 | 0.88 |
| T3C | 220 | 18.26 | 0.495 | 1.02 |
| | 220 | 18.26 | 0.495 | 1.02 |
| | 210 | 17.43 | 0.473 | 0.97 |
| T3D | 225 | 18.68 | 0.506 | 1.04 |
| | 220 | 18.26 | 0.495 | 1.02 |
| | 210 | 17.43 | 0.473 | 0.97 |

**T3A : Group of rats fed on anemic diet plus 2.0 gm husk tomato fruit**
**T3B : Group of rats fed on anemic diet plus R.D.A of Fe from husk tomato fruit**
**T3C : Group of rats fed on control diet plus 2.0 gm husk tomato fruit**
**T3D : Group of rats fed on control diet plus R.D.A of Fe from husk tomato fruit**

Feeding control diet increased and decreased significantly cholesterol content after 8 weeks compared with the zero time and adaptation period, respectively. Meanwhile cholesterol increased significantly as a result of feeding high fat diet which amounted in 115.05 mg/dl which about 1.5 fold as that of zero time. Feeding high fat diet containing 2.0 gm husk tomato (group 3) resulted in similar amount as that of zero time (61.3 vis 61.0 mg/dl) meanwhile the same diet containing 1.0 gram husk tomato (group 4) showed a significant increase in cholesterol content which amounted in 67.03 due to feeding period but non-significant due to husk tomato blends. When control diet blended with husk tomato either at 2 or 1 gm% (treatments 5 and 6), the data reveal a significant increase in cholesterol content of both treatments due to period or treatment, respectively at the end of the studied period.

From the above mentioned data, it could be concluded that addition of 2.0 gm of husk tomato/100 gm diet decreased significantly total serum cholesterol of hypercholestrolemic patients. This reduction could be attributed to the presence of dietary fiber in the fruits (5.0%) and to the average of energy content (31 Kcal/100 gm), (Bock *et al.*, 1995).

Generally, husk tomato is considered as a rich source of some nutrients and could be used as a blend with some other fruits such as mango, carrots, orange, .....etc..

**Table (11): Effect of feeding husk tomato fruit on serum cholesterol level in rats**

| Treatments | Cholesterol mg/ dl | | Cholesterol content during repletion period | | | | L.S.D 0.05 |
|---|---|---|---|---|---|---|---|
| | Zero | After Depletion Period (15 days) | 25 days | 35 days | 45 days | 55 days | |
| 1 | 61.0 $^{De}$ | 82.5 $^{Af}$ | 82.0 $^{Ac}$ | 79.05 $^{Bc}$ | 75.2 $^{Cc}$ | 75.45 $^{Cc}$ | 2.138 |
| 2 | 76.5 $^{De}$ | 97.95 $^{Ce}$ | 111.4 $^{Ba}$ | 114.5 $^{Aa}$ | 115.1 $^{Aa}$ | 115.05 $^{Aa}$ | 1.139 |
| 3 | 61.0 $^{Ce}$ | 123.8 $^{Ac}$ | 72.67 $^{Be}$ | 72.0 $^{Be}$ | 61.5 $^{Cf}$ | 61.3 $^{Cf}$ | 0.813 |
| 4 | 65.33 $^{Ed}$ | 131.6 $^{Ab}$ | 76.43 $^{Bd}$ | 75.47 $^{Cd}$ | 67.1 $^{Dd}$ | 67.03 $^{Dd}$ | 0.777 |
| 5 | 81.0 $^{Fb}$ | 137.17 $^{Aa}$ | 108.83 $^{Bb}$ | 100.83 $^{Cb}$ | 95.8 $^{Db}$ | 86.63 $^{Eb}$ | 1.188 |
| 6 | 91.0 $^{Ba}$ | 104.47 $^{Ad}$ | 71.27 $^{Cf}$ | 68.2 $^{Df}$ | 65.27 $^{Ee}$ | 63.6 $^{Fe}$ | 0.859 |
| L.S.D 0.05 | 1.742 | 0.6356 | 1.068 | 1.356 | 0.658 | 0.571 | |

**Capital letters for periods (days)**
**Small letters for treatments (1-6)**
*** Means with the same letter are not significantly different**

| |
|---|
| : Group of rats fed on control diet up to 8 weeks |
| : Group of rats fed on high fat diet up to 8 weeks |
| : Group of rats fed on high fat diet contained 2.0 gm husk tomato fruit |
| : Group of rats fed on high fat diet contained 1.0 gm husk tomato fruit |
| : Group of rats fed on control diet contained 2.0 gm husk tomato fruit |
| : Group of rats fed on control diet contained 1.0 gm husk tomato fruit |

## REFERENCES


Abd-El-Ghani, T. and S.A. El-Farra (1994). Nutritional value of husk tomato seeds. Annals-of-Agricultural-Science, Moshtohor, 32 (3): 1611-1622.

Abou-Gharbia, H.A. and E.M. Abou-Tour (2001). Properties and processing of husk tomato (*Physalis pruinosa*, L.). Minufiya J. Agric. Res., 26 (3) : 761-781.

Anon, (2001).The average production of husk tomato fruits (2001). Statistical report, Horticulture Res. Institute, Agric. Res. Center, Giza, Egypt.

A.O.A.C. (1990). Official Methods of Analysis of the Association of Official Analytical Chemists. 15th Ed. Washington 4 D.C., U.S.A.

Bock, M.A.; J. Sanchez-Pilcher; L.J. McKee and M. Ortiz (1995). Selected nutritional and quality analyses of tomatillos (*Physalis ixocarpa*). Plant foods for Human Nutrition, 48 (2): 127-133.

Cantwell, M.; J. Flores-Minutti and A. Trejo-Gonzalez (1992). Developmental changes and postharvest physiology of tomatillo fruit (*Physalis ixocarpa* Brot.). Scietia Horticulturae; 50 (1/2) : 59-70.

Fairweather-Tait, S.J. and S. Southan (1989).Studies of iron, zinc interactions in adult rats and the effect of iron fortification of two commercial infant weaning product on iron and zinc status of wealing rats. J. Nutr. 119:599-606.

Fashakin, J.B. and S. Oladimeji (1986). Effect of ascorbic acid on the availability of iron in weaning foods. Ann. Nutr. Metab., 30: 324-330.

Goodhart, R.S. and M.E. Shills (1983). "Modern Nutrition in health and disease". 6th Ed. Lea and Febiger, Philadelphia.

Hegsted, D.M.; R. Mills; C.A. Elvehjem and E.B. Hart (1941). "Choline in the nutrition of chicks". J. Biol. Chem., 138: 4-7.

Henry, R. (1964). Principles and techniques, Clinical Chemistry, Harper and Row, New York, p. 747.

Hurrell, R.F. ; M.B. Reddy ; S.A. Dassenko ; J.D. Cook and D. Shepherd (1991). Ferrous fumarate fortification of a chocolate drink powder. British J. of Nutr., 65:271-283.

Jankiewicz, L.S. (1989). The biology and nutritional value of the tomatillo (*Physalis ixocarpa* Brot.). Builetyn-Warzywniczy. Suppl. II, 223-231.

Ostrzycka, J.; M. Horbowicz; W. Dobrazanski; L.S. Jankiewicz and J. Borkowski (1988). Nutritive value of tomatillo fruit (*Physalis ixocarpa* Brot.). Acta Scietatis Botanicorum Poloniae, 57 (4): 507-521.

Raghava, R.P. and Nisha-Raghava (1990). Carotenoid content of husk tomato under the influence of growth regulators and gamma rays. Indian Journal of plant Physiology, 33 (1): 87-89.

Rahman, A.S.; M. Kimura; K. Yokoi and Y. Etokawa (1995). Iron, zinc and copper levels in different tissues of clinically vitamin A-deficient rats. Biological Trace Element Research, 49: 75-84.

Ranganna, S. (1977). Manual of analysis of fruit and vegetable products. Tata Mc. Graw Hill Publishing Company Limited, New delhi.

Ranhotra, G.S.; R.J. Loewe and L.V. Puyat (1973). Availability of iron in enriched soda crackers. Cereal Chem., 50: 745-749.

Rawe, C.J.. (1973). Food analysis by Atomic Absorption Spectroscopy. Varian Tech. Australia, U.S.A. Switzerland.

Roodenburg, J.C.; C.E. West; R. Howvenier and A.C. Beynen (1995). Comparison between time-dependent changes in iron metabolism of rats as induced by marginal deficiency of either vitamin A or iron. British J. of Nutr., 72:687-699.

Rouse, A.H. and C.D. Atkins (1955). Pectinesterase and pectin in commercial citrus juices. Florida Agric. Expt. Sta. Bull 570.

Sigata, M.T.; B.C.E. Ramirez and A. Pena-Lomeli (1994). Determination of simple sugars and acidity in accessions of husk tomato (*Physalis ixocarpa* Brot.). Revista-Chapingo-Serie-Horticulture, 1 (2): 141-143.

Snedecor, G.W. and W.C. Conchran (1980). Statistical method, Oxford and J.B. 4 Publishing Com. 7th Edition.

Somogyi, M. and N. Nelsen (1952). Notes on sugar determination. J. Biol. Chem., 195 : 19-23.

Syrov, V.N.; Z.A. Khuskbaktova and O.E. Vasina (1989). Anti-inflamatory properties of vitanolides. Khimiko-Far matsevticheskii-Zhurnal, 23 ( 5): 610-613.

Thomas, L.; and L. Diagnose (1992). Enzymatic colorimetric test (CHOD-PAP), 4th Ed. Pp. 438.

Umiel, N. and W.H. Gabelman (1971). Analytical procedures for detecting carotenoids of carrot and tomato fruits. J. Am. Soc. Hortic. Sci., 26 : 702.

Van-Houwelingen, F.; G.J. Van-Den Berg; A.G. Lemmens and K. Sijtsma (1993). Iron, zinc levels in different tissues of rats. Boil. Trace Element Res., 38:83-95.

Venkatarman, L.V.; W.E. Becker; T. Rajasekaram and K.R.Mathew (1979). Investigation on the toxicology and safety of algal diets in albino rats Food and Cosmetics Toxicology, 18: 271-275.

Walter, W.M. and M.W. Hoover (1986). Preparation, evaluation, and analysis of a French fry type product from sweet potatoes. J. Food Sci., 15 : 967.

William, P. (1990) In vitro predication of iron bioavailability for food iortification. Nutrition Reports International , 38:1205-1215.

Wolff, X.Y. (1991). Species, cultivar and soil amendments influence fruit production of two physalis species. Hortscience, 26 (12) : 1558-1559.

## التقييم الكيماوي والبيولوجي لثمار الحرنكش كمخفض لكوليسترول الدم ومقـــاوم للأنيميا

**ثريا عبد الغني و لبني عبد الفتاح محمد هريدي و ستوته أحمد الفرا**
**معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة**

نظراً لإرتفاع جودة ثمار الحرنكش حيث اللون الأصفر والنكهة المقبولة سواء كان ثمرة طازجـــة أو منتج محفوظ (مربي , جيلي أو صلصة) فقد تم التقييم الكيماوي والبيولوجي لـــهذه الثمـــار حيـــث كـــان المستخلص العصيري (يمثل ٧٧%) غني بحمض الأسكوربيك (١٢٠ ملجم / ١٠٠جم) وحامض الأكســـاليك ٧٢,٢١ ملجم/١٠٠ جم والسكريات الكلية (٢٦,٣٢%) والكاروتينويدات (١٢,٤٩ ملجم / ١٠٠ جم) (علـــي أساس الوزن الجاف) وإحتوي الغلاف الخارجي والقشرة علي كمية وفيرة من البكتيـــن ١٠,٥١ ، ٢٠,٥٩% علي التوالي. وعلي الجانب الأخر إحتوي الغلاف الخارجي علي نسب مضاعفة من الكاروتينويدات مقارنـــة بالقشرة (١٠,٤٣ مقابل ٤,٣٠ ملجم / ١٠٠جم) كذلك إحتوت البذور الداخلية علي ١٦,٢٧ ، ١٦,٠٩% مـــن كلاً من البروتين الكلي والليبيدات علي التوالي. وإحتلت المواد الكربوهيدراتية والألياف المركز الأول كمـــواد أساسية في البذور والغلاف الخارجي والقشرة للثمار موضوع الدراسة. أظهر التقيـــيم البيولوجـــي لثمـــار الحرنكش المجففة وتأثيره علي مكونات الهيموجلوبين وأثره علي المرضـــي الذيـــن يعـــانون مـــن إرتفـــاع الكونيسترول أنه ذو أثر جيد عندما يؤخذ بمقدار ٢ جم (٨,٧جم طازج) في اليوم. ونستخلص من هـــذا أن تناول ٢ جم من الحرنكش المجفف (٨,٧ جم طازج) يومياً يحسن من حالة الأنيميا ويرفع هيموجلوبين الـــدم وكذلك يخفض مستوي الكوليسترول في السيرم والكبد.