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# NUTRITIONAL EVALUATION OF SOME VEGETABLE CROPS BY-PRODUCTS AS UNCONVENTIONAL FEEDSTUFFS IN RABBITS FEEDING.

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*The main target of this study was to evaluate some vegetable crops by-products ( Green bean vines, GBV; Peas vines, PV ; Squash vines, SV; Cantaloupe vines, CV and Artichoke leaves, AL) as unconventional feedstuffs in rabbits feeding. Different chemical and biological procedures had been done, these include proximate analysis, crude fiber fractions, amino acid determination, anti-nutritional factors and minerals determination. Seven indirect digestibility trails were conducted to evaluate the digestion coefficients of nutrients and to calculate the nutritive values (as total digestible nutrients, TDN; digestible crude protein, DCP and digestible energy, DE) for different tested feedstuffs. Twenty one adult male New Zealand White rabbits, 7 months of age with an average live body weight ranged from 2178 to 2227g, were allotted randomly to seven groups of three rabbits each.*

*The obtained results indicated that the highest content of CP (14.17%) was recorded by SV followed by PV (13.79%), GBV (13.41%), CH (13.5·%) and CV (12.58%) while, the lowest CP content was observed with AL (11.43%). The highest CF content of tested vegetable crops by-products was recorded by CV (30.85%) and the lowest content by PV (23.76%) while CF content for other by-products was found to be between these two ranges. Clover hay; PV and GBV were nearly similar in NDF contents. Also the ADF contents of SV, GBV and PV were nearly similar (32.30, 33.20 and 34.50%, respectively). The amino acids composition confirms that tested vegetable crops by-products demonstrated shortage of sulfur amino acids (methionine and cystine). While, such materials have remarkably higher amounts of acidic amino acids, aspartic and glutamic. Regarding to phytate content, CV recorded the highest value followed in a decreasing order by PV, AL, SV and GBV (2.37, 1.99, 1.91, 1.62 and 1.13%). Oxalate content was ranged between 6.24% for AL to 10.98% for GBV. Results showed PV had the highest content of saponin (12.70%);*

*Nutritive values of PV, GBV, SV, CV, and AL compared with clover hay revealed that PV, GVB and SV had the highest nutritive values and they are nearly similar to the nutritive values of clover hay.*

*In general, the positive results of the nutritive values of tested vegetable crops by-products (PV, GBV and SV) as compared with clover hay show the possibility of using these by-products as suitable unconventional feedstuffs in replacement of clover hay in growing rabbits diets at certain levels.*

**Key words:** *Vegetable crops by-products; nutritional evaluation; chemical composition; digestibility & nutritive values.*

Vegetable crops cultivation has been increased in Egypt during the last three decades to be 15,552,303 tones yearly (Ministry of agriculture, 2004). There are large quantities of vegetable crops by-products left over of this production such as dried green tops (vines), may help in solving the feedstuffs shortage problem. Vegetable residues are the plant materials that remained after harvesting of vegetable crops. Most of them are discarded in the field as organic fertilizers or burned causing environmental pollution, but some are dried and stored as a forage sources for ruminants or they may be left in the field for grazing (Renard, 2001). Clover hay is the most common source of fiber used in rabbit diets, accounting for 30-40% of the commercial diet. So, substituting clover hay by other fibrous sources such as locally vegetable crops residues can reduce feeding costs (Pote *et al.*, 1980). At the same times, rabbits have the ability to utilize forage and these by-products as major diet component that make them suitable as meat producing small livestock in developing countries. In many areas in developing countries, rabbit production could be an effective means of converting forages and by-products into high quality animal protein (Cheeke, 1986).

The objective of this current study was to evaluate some vegetable crops by-products (Green bean ( *Phaseolus vulgaris*) vines; Peas (*Pisum sativum*) vines; Squah (*Cucurbita pepo L.)* vines; Cantaloupe (*Cucumis melo var. reticulatus*) vines and Artichoke (*Cynara scolymus* ) leaves) as non-conventional feedstuffs in rabbits feeding.

## MATERIALS AND METHODS

The experimental work of this study was carried out at Gezeeret El-Sheir Experimental Station, El-Kanater El-Khayria, Kalyobia Governorate, Ministry of Agriculture, Egypt during the period from September, 2008 till January 2009. Chemical analysis was conducted at the Laboratory of By-products Research Department of Animal Production Research Institute.

Green bean vines, Pea vines, Squash vines were obtained from El-Kalubia Governorate. While, Cantaloupe vines and Artichoke leaves were obtained from new reclaimed land in Nubaria, El-Behera Governorate. These vegetable crops by-products were dried by sun-drying to nearly 10% moisture content, then ground by hammer mill and kept for subsequent processing.

**Digestibility trials**

Digestibility trails were conducted to determine the digestion coefficients of the nutrients and the nutritive values (TDN, DCP and DE) of clover hay and tested vegetable crops by-products (green bean vines, pea vines, squash vines, cantaloupe vines and artichoke leaves) by different method (Close and Menke, 1980). A basal ration was formulated from clover hay, the tested feedstuffs rations were formulated from 25% barley and 75% tested vegetable crops by-products (PV, GBV, SV, CV and AL). Twenty one adult male New Zealand White rabbits, 7 months of age with an average live body weight ranged from 2178 to 2227g, were used in digestibility evaluation and allotted randomly to seven groups of three rabbits each. Rabbits were housed in individual metabolism cages and fed the experimental diets for a period of 7 days (preliminary period) to allow the rabbits to become adjusted to cages then the faeces were collected every 24 hours for 5 consecutive days (collection period). Daily faecal output during the collection period was determined and oven dried (60°C) and stored in screw-top glass jars for the routine chemical analysis. The clover hay and the tested materials were pelleted and offered to rabbits to meet all the maintained nutrient requirements of growing rabbits according to NRC (1982).

**Proximate analysis**

Chemical analyses for determining moisture, CP, CF, EE, NFE, ash and minerals for the tested vegetable crops by-products, diets and feces were done according to the methods recommended by A.O.A.C (1999).

**Fiber fractionation:**

Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined according to Van Soest *et al.* (1991). Hemicellulose and cellulose were calculated as follows:

Hemicellulose = NDF-ADF;

Cellulose = ADF-ADL

**Determination of amino acids**

Amino acids composition of tested materials was determined by Automatic Amino acids Analyzer (AAA 400) INGOS Ltd. Acid hydrolysis was carried out according to the method of Blok *et al.*, (1958).

**Determination of Anti-nutritional factors**

oxalate content was determined according to Oke (1969). tannins were determined using vanillin hydrochloric acid method as described by Burn (1971) and saponin was determined by using the method of Shany *et al.*, (1970).

**Statistical analysis**

The data were statistically analyzed using GLM (general linear models) procedure of SAS (2000) by one-way ANOVA according to the following statistical model:

$$Xij = \mu + Ti + e_{ij}$$

Where: Xij= The j th observation in the i th treatment, μ = Overall mean; Ti = Treatment groups (i= 1- 13); $e_{ij}$ = Random effect.

Significant differences among treatment means were detected using Duncan`s multiple range of test (Duncan, 1955).

## RESULTS AND DISCUSSION

***Chemical evaluation***

Results in Table (1) indicated that DM content of all tested vegetable crops by-products are nearly similar and ranged between 90.01% in PV and 91.9% in CH while, OM content ranged from 73.66% in CV to 92.85% in PV. The highest content of CP (14.17%) was recorded by SV followed by PV (13.79%), GBV (13.41%), CH (13.40%) and CV (12.58%), on the other hand the lowest CP content was observed with AL (11.43%), respectively. These results are in agreement with those obtained by Preston (2002); Sarhan (2005); Stanton and LeVally (2007), and Abdo *et al.*, (2007). It is clearly to notice that leguminous by-products such as PV and GBV are very comparable to clover hay and having higher CP% content than other tested vegetable crops by-products.

Regarding to EE content, CH recorded the highest value (4.04%) followed by PV (2.18%), SV (2.02%), AL (1.70%) and CV (1.12%) while, the lowest value recorded by GBV (1.06%).

Results in Table 1 noticed that the highest CF content of tested vegetable crops by-products was recorded by CV (30.85%) and the lowest content by PV (23.76%) while CF content for other by-products was found to be between these two ranges. The CF obtained of PV (23.76%) was found to be higher than those values obtained by Zeweil *et al.*, (1990) and Zeweil (1992) (17.15 to 19.23%,respectively). While, CF content was found to be within the range obtained by Gupta *et al.*, (1993) and Sarhan (2005). On the other hand, Stanton and LeVally (2007) and Kathy and Robert (2009) stated that pea vine hay contained 30.2 to 32.0% CF content. The content of CF in GBV (28.10%) was observed to be less than the value which recorded by Tag El Din *et al.* (2002)

**Table 1. Chemical composition of tested vegetable crops by-products compared to clover hay (on DM basis).**

| Items (%) | Vegetable crops by-products | | | | | |
|---|---|---|---|---|---|---|
| | CH | PV | GBV | SV | CV | AL |
| *Proximate analysis (%):* | | | | | | |
| DM | 91.95 | 90.01 | 90.74 | 90.07 | 90.65 | 90.30 |
| OM | 87.17 | 92.85 | 87.70 | 87.50 | 73.66 | 92.52 |
| CP | 13.40 | 13.79 | 13.41 | 14.17 | 12.58 | 11.43 |
| EE | 4.03 | 2.18 | 1.06 | 2.02 | 1.12 | 1.70 |
| CF | 26.03 | 23.76 | 28.10 | 26.70 | 30.85 | 23.95 |
| NFE | 43.71 | 53.12 | 45.13 | 44.61 | 29.11 | 55.44 |
| Ash | 12.83 | 7.15 | 12.30 | 12.50 | 26.34 | 7.48 |
| *Crude fiber fractions* | | | | | | |
| ADF | 30.06 | 34.50 | 33.20 | 32.30 | 47.78 | 41.27 |
| NDF | 43.20 | 42.70 | 40.01 | 39.20 | 54.13 | 52.49 |
| ADL | 5.54 | 7.70 | 8.01 | 6.10 | 14.32 | 6.89 |
| Hemicellulose[1] | 13.14 | 8.20 | 6.81 | 6.90 | 6.35 | 11.22 |
| Cellulose[2] | 24.52 | 26.8 | 25.19 | 26.20 | 33.46 | 34.38 |
| *Minerals analysis (%):* | | | | | | |
| Ca | 1.50 | 1.20 | 1.43 | 1.35 | 1.27 | 1.62 |
| P | 0.25 | 0.21 | 0.19 | 0.32 | 0.33 | 0.21 |
| K | 1.70 | 1.20 | 1.50 | 0.67 | 0.95 | 1.4 |
| Mg | 0.33 | 0.27 | 0.30 | 0.20 | 0.19 | 0.31 |
| Na | 0.09 | 0.07 | 0.08 | 0.06 | 0.02 | 0.03 |

CH: Clover hay PV: Pea vines GBV: Green bean vines
SV: Squash vines CV: Cantaloupe vines AL: Artichoke leaves
1-Hemicellulose = NDF-ADF
2-Cellulose = ADF-ADL

(34.33% CF). While, Kathy and Robert (2009) stated that the CF% content of green bean straw was 24.0%. Preston (2002) reported lower artichoke tops CF content (18%) than those obtained in this present study. It is well known that the chemical composition of these vegetable crops by-products varied according to species, stages of maturity, harvest date, level of fertilization and soil.

***Crude fiber fractions***

Results in Table (1) showed that CH, PV, GBV and SV recorded similar fiber fractions values, while CV and AL showed higher values. In this regard Nouala *et al.*, (2004) obtained lower values of NDF and ADF for Pea vines, while Preston (2002) reported that pea vines had higher values of ADF and NDF (52% and 62%, respectively) compared with those results obtained in this study.

Concerning to NDF and ADF contents of AL (52.49 and 41.27%), these results are nearly in agreement with those obtained by Lindberg *et al.*, (1986) While, these results were lower than values obtained by Preston (2002). On the other hand, Sallam (2005) reported lower fiber fractionations of AL compared with NDF and ADF values of this study.

Acid detergent lignin (ADL) content of CV recorded the highest value (14.32%) while; the lowest value (5.54%) was recorded by clover hay. It was noticed that PV, GBV, SV and AL were nearly similar in ADL content (7.7, 8.1, 6.10 and 6.89%, respectively). The recorded ADL value of AL (6.89%) was found to be lower than that obtained by Sallam (2005) who found that AL contained 8.94% ADL.

As presented in Table (1), clover hay recorded the highest hemi-cellulose value while CV and AL recorded the highest cellulose values among all tested materials. These results was higher than results obtained by Sallam. (2005) who found that the Jerusalem artichoke residues contained 19.63% hemicellulose.

***Minerals content***

Results in Table (1) indicated that Ca content ranged from 1.20% in PV to 1.62% in AL. Regarding to P content, the values ranged from 0.19% in GBV to 0.33% in CV. while, PV and AL were nearly similar in P content (0.21%), respectively. Clover hay had the highest value of K (1.70%) compared with other materials. Magnesium content of CH, GBV and AL was found to be similar, while CH had higher Na level. In this respect, the values of Ca, P, K, Mg and Na of CH are within those ranges reported by Maertens *et al.*, (2002) who found that Lucerne meal had 1.50, 0.26, 0.07, 0.27 and 2.10% for Ca, P, Na, Mg and K). Also, NRC (1977) found that alfalfa hay contained 1.13% Ca, 0.24% P, 0.12% Na and 0.29% Mg. Minerals values of PV are found to be similar to values reported by Preston (2002),who found that PV hay contained 1.20, 0.21, and 1.2% for Ca, P, K, respectively. Results of minerals values of this present study are also agreed with results recorded by (Stanton and leValley, 2007) who found that PV hay contained 1.2% Ca, 0.21% P and 1.8% K.

***Amino acids composition of tested vegetable crops by-products.***

The essential and the non-essential amino acids composition of tested vegetable crops by-products (PV, GBV, SV, CV and AL) are shown in Table 2. It is clearly to notice that total amino acids values ranged from 3.20% in CV to 4.49% in PV. Pea vines recorded the highest values for either the total amino acids or the essential amino acids (4.49 and 2.20%, respectively) among all other vegetable crops by-products. On the other hand, CV achieved the lowest values (1.35 and 1.85%) for both essential and non-essential amino acids.

Regarding to essential amino acids, methionine was the first limiting amino acid in all tested materials followed by histidine for (PV, GBV, SV and CV); and Arginin was the second limiting amino acid for AL.

Concerning to the non-essential amino acids, the most shortage amino acid was cystine for tested vegetable crops by-products. Besides, the CV had the lowest value of proline (0.09%) compared with all tested by-products. In general, the present results of the amino acids composition confirm that tested vegetable crops by-products (PV, GBV, SV, CV and AL) demonstrated shortage of sulfur amino acids (methionine and cystine). While, such materials have remarkably higher amounts of acidic amino acids, aspartic and glutamic (Table 2).

These results are nearly in agreement with previous findings obtained by Hussein *et al.*, (1999) who found that leaf protein concentrate prepared from different plant species such as alfalfa, artichoke, cabbage, carrot, clover and kidney bean contained acceptable levels of all essential amino acids except methionine which was the limiting amino acids for all leaf protein concentrates. On the other hand, Carlsson and Hanczakowski (1989) who reported that leaf protein concentrate prepared from pea vines contained 1.9 g per 16 g N methionine and 1.3 g per 16 g N cystine. They also stated that the best leaf protein concentrate with the highest protein quality was obtained from pea vine. Furthermore, some essential acids content of pea vine protein such as valine, leucine and phenylalanine were found to be better. Serena and Bach Knudsen (2007) found that the pea hull had higher content of lysine and arginine as essential amino acids and also aspartic and glumatic acid as non-essential amino acids. Regarding to artichoke leaves, Abdo *et al.*, (2007) found that artichoke leaves meal contains 0.51% and 0.42% arginin and leucine , respectively. The above mentioned findings regarding to leucine value is quite similar to the value obtained for leucine in the current study (0.38%).

**Table 2. Amino acids compostion of tested vegetable crops by-products (on DM basis).**

| Items | Vegetable crops by-products | | | | |
|---|---|---|---|---|---|
| | PV | GBV | SV | CV | AL |
| **Total amino acids (%)** | **4.49** | **4.19** | **3.67** | **3.20** | **4.21** |
| *Essential amino acids (%)* | | | | | |
| **Arginin** | 0.32 | 0.31 | 0.19 | 0.17 | 0.13 |
| **Threonin** | 0.22 | 0.21 | 0.42 | 0.13 | 0.21 |
| **Histidine** | 0.14 | 0.15 | 0.10 | 0.10 | 0.15 |
| **Isoleucine** | 0.21 | 0.20 | 0.14 | 0.13 | 0.19 |
| **Leucine** | 0.42 | 0.36 | 0.28 | 0.26 | 0.38 |
| **Lysine** | 0.35 | 0.33 | 0.21 | 0.20 | 0.27 |
| **Methionine** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Phenylelalanine** | 0.26 | 0.20 | 0.19 | 0.18 | 0.24 |
| **Tryptophan*** | - | - | - | - | - |
| **Valine** | 0.28 | 0.20 | 0.19 | 0.18 | 0.26 |
| **Total** | **2.20** | **1.96** | **1.72** | **1.35** | **1.83** |
| *Non-essential amino acids (%)* | | | | | |
| **Alanine** | 0.30 | 0.30 | 0.23 | 0.24 | 0.30 |
| **Aspartic acid** | 0.47 | 0.45 | 0.46 | 0.44 | 0.65 |
| **Glutamic acid** | 0.40 | 0.45 | 0.44 | 0.52 | 0.39 |
| **Glycine** | 0.24 | 0.25 | 0.19 | 0.21 | 0.24 |
| **Proline** | 0.32 | 0.24 | 0.21 | 0.09 | 0.36 |
| **Serine** | 0.20 | 0.24 | 0.19 | 0.12 | 0.22 |
| **Cystine** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Tyrosine** | 0.36 | 0.30 | 0.23 | 0.23 | 0.22 |
| **Total** | **2.29** | **2.23** | **1.95** | **1.85** | **2.38** |

PV: Pea vines GBV: Green bean vines SV: Squash vines
CV: Cantaloupe vines AL: Artichoke leaves. * Not determined

***Anti-nutritional factors of tested vegetable crops by-products.***

The results of anti-nutritional factors are presented in Table 3. Cantaloupe vines recorded the highest values of phytate content (2.37%) and phytic acid (2.21%). On the other hand, GBV recorded the lowest values (1.13 and 1.04%, respectively).

**Table 3. Anti-nutritional factors of tested vegetable crops by- products (on DM basis).**

| Items | Vegetable crops by-products | | | | |
|---|---|---|---|---|---|
| | PV | GBV | SV | CV | AL |
| Phytate% | 1.99 | 1.13 | 1.62 | 2.37 | 1.91 |
| Phytic acid % | 1.86 | 1.04 | 1.50 | 2.21 | 1.79 |
| Oxalate % | 7.50 | 10.98 | 8.50 | 9.80 | 6.24 |
| Tannins% | 1.90 | 2.01 | 0.77 | 0.98 | 2.58 |
| Saponin % | 12.70 | 8.20 | 8.40 | 7.80 | 6.80 |

PV: Pea vines GBV: Green bean vines SV: Squash vines
CV: Cantaloupe vines AL: Artichoke leaves.

Phytates is known to chelate several mineral elements, especially Ca, Mg, Fe, Zn and Mo, and interfere with their absorption and utilization. Mateos and DeBlas (1998) supposed that phytate P is well utilized in the rabbit because of phytase production by the microorganisms of the caecum and recycling of P through soft faeces and caecotrophy. Concerning oxalate content, the values were ranged from 6.24% for AL to 10.98% for GBV. In this trend (Oke, 1969) reported that oxalates affect Ca and Mg metabolism and react with proteins to form complexes which have an inhibitory effect on peptic digestion. Tannins content ranged from 0.77% for SV to 2.58% for AL. These results are nearly in agreement with those obtained by Schutz *et al.*, (2004) who reported that the total phenolic content was approximately 12 g/kg on a dry matter basis in artichoke pomace. The presence of tannins found to decrease the nutritional value of feedstuffs for non-ruminant animals by reducing retention of protein, digestibility of dry matter and metabolic rate of gross energy as well as inhibition of digestive enzyme activity (Li and Zahang, 1998).

As shown in Table (3), it is clearly to notice that PV had the highest content of saponin (12.70%) followed by SV (8.40%), GBV (8.20%), CV (7.8%) and AL (6.80%). In this trend Fenwick and Oakenfull (1983) found that Lucerne and varieties of *phaseolus vulgaris* were the richest level in saponins content (56 and 87 g $kg^{-1}$ dry materials, respectively). Besides, green beans (*P. vulgaris*) and green peas contained (13 and 11 g $kg^{-1}$ dry materials, respectively). The saponin content of plants is of interest because dietary saponins have been shown to lower plasma cholesterol concentration in several species of animal.

**Biological evaluation**

***Digestion coefficients and nutritive values of tested vegetable crops by-products.***

Data in Table 4, indicated that there was no significant (P<0.05) difference between CH and PV and between PV and GBV in the digestibility of DM While, there was a significant (P<0.05) decrease in DM digestibility by 12.12, 20.19, 21.28 and 27.47% for GBV, SV, CV and AL respectively compared with CH. Abdel-Magid *et al.*, (2005) reported lower results of DM digestibility for kidney bean straw and pea straw.

It could be noticed that CH recorded the highest (P<0.05) value for OM digestibility (61.68%) compared with all other tested vegetable crops by-products. Regarding to CP digestibility, the present results showed that there were significant decrease (P<0.05) between CH and the all other tested vegetable crops by-products in CP digestibility by 19.24, 22.20, 35.73, 49.82 and 55.47% for PV, GBV, SV, CV and AL respectively compared with CH, respectively. (Villamide *et al.*, 1998) reported that Lucerne meal recorded 60% CP digestibility. EE digestibility of CH recorded the highest (P<0.05) value compared with all other vegetable crops by-products.

Results of CF digestibility indicated that CH achieved the highest (P<0.05) value (45.58%) compared with the other tested vegetable crops by-products. However, CV recorded the lowest (P<0.05) value (27.73%) among all tested materials. Meantime, there were no significant differences between PV, GBV and SV in CF digestibility. Gidenne and LeBas (2002) confirmed that the digestive health of rabbit is dependant on the level and quality of lignocellulosic content of the diets and incorporating fiber sources rich in digestible fiber in the rabbit feeds covers a double interest. Digestible fiber is highly utilized for growth, and they improve the digestive health of the animal as a results of their high digestibility.

Concerning to NFE digestibility, results stated that GBV and PV recorded the highest (P<0.05) values of NFE digestibility (Table 4). These results were partially similar to those reported by Abdel-Magid *et al.*, (2005) who found that the NFE value of kidney bean straw was 73.87% and pea straw was 69.48% while, GBV had 54.06% digestibility coefficient respectively.

Nutritive values of tested PV, GBV, SV, CV, and AL compared with clover hay as shown in Table (4). Analysis of variance revealed that significant differences were detected among all tested vegetable crops by-products. Clover hay and PV recorded the highest (P<0.05) TDN and DE values compared with all vegetable by-products. Meantime, there was a significant decrease (P<0.05) in TDN and DE for SV, CV and AL, while, there were significant (P<0.05) differences between CH and other tested vegetable crops by-products in DCP.

**Table 4. Digestibility coefficients and nutritive values of tested vegetable crops by-products.**

| Items (%) | Vegetable crops by-products | | | | | | |
|---|---|---|---|---|---|---|---|
| | **CH** | **PV** | **GBV** | **SV** | **CV** | **AL** | **±SE** |
| ***Digestibility coefficients*** | | | | | | | |
| **DM** | $69.97^{a}$ | $65.55^{ab}$ | $61.49^{b}$ | $55.84^{c}$ | $55.08^{c}$ | $50.75^{c}$ | 1.71 |
| **OM** | $61.68^{a}$ | $54.71^{b}$ | $52.64^{b}$ | $45.16^{c}$ | $33.43^{d}$ | $43.43^{c}$ | 1.32 |
| **CP** | $70.83^{a}$ | $57.20^{b}$ | $55.10^{b}$ | $45.52^{c}$ | $35.54^{d}$ | $31.54^{d}$ | 2.18 |
| **EE** | $76.82^{a}$ | $65.67^{b}$ | $64.94^{b}$ | $60.58^{c}$ | $60.20^{c}$ | $37.53^{d}$ | 0.81 |
| **CF** | $45.58^{a}$ | $36.70^{b}$ | $34.63^{b}$ | $35.31^{b}$ | $27.73^{c}$ | $34.28^{b}$ | 1.25 |
| **NFE** | $66.05^{cd}$ | $69.22^{ab}$ | $71.39^{a}$ | $68.20^{bc}$ | $63.71^{d}$ | $53.71^{e}$ | 0.91 |
| ***Nutritive values (on DM basis)*** | | | | | | | |
| **TDN** | $57.19^{a}$ | $56.60^{a}$ | $50.89^{b}$ | $49.05^{c}$ | $33.09^{d}$ | $43.03^{c}$ | 0.52 |
| **DCP** | $9.49^{a}$ | $7.89^{b}$ | $7.39^{b}$ | $6.45^{c}$ | $4.47^{d}$ | $3.61^{e}$ | 0.27 |
| **DE* (Kcal/kg)** | $2533^{a}$ | $2507^{a}$ | $2254^{b}$ | $2173^{c}$ | $1465^{d}$ | $1906^{c}$ | 23.14 |

a,b,c— Means in the same row with different superscripts are significantly different (P<0.05).
*DE (kcal/kg) = TDN X 44.3 according to Schneider and Flatt (1975).

Clover hay recorded the highest DCP value. On the other hand, AL had the lowest (P<0.05) DCP value (3.61%). Insignificant differences were observed between PV and GBV (Table 4).

The recorded low DCP value of AL could be attributed to polyphenolic compounds in artichoke leaves. These results are confirmed by Huisman and Tolman (1992) who reported that polyphenolic compounds considered as an anti-nutritional factors that have a depressive effect on protein digestion and utilization in addition to digestion of carbohydrates. Makled *et al.*, (2003) reported that the addition of tannic acid to rabbit diets significantly decreased all digestibility coefficients of the nutrients of the diets supplemented by either 0.25 or 0.50 % tannic acid and also showed the same trend of decreasing the nutritive values of feed included tannic acid (0.25%).

In this respect, results of TDN of CH are nearly in agreement with those obtained by Abdel-Magid *et al.*, (2005) who reported that clover hay had 56.39% TDN. On the other hand, DCP of CH in the present study is higher than those found by the same authors who found that DCP of clover hay was 7.79%. The findings of this present study are also in agreement with Villamide *et al.*, (2003) who found that alfalfa meal had 9.31% DCP value when evaluated by rabbits. The findings also revealed that TDN of pea vines were less than those reported by Stanton and Levalley (2007) who found that pea vine hay had 59.0% TDN, while, Preston (2002) stated that pea vines hay contained 60% TDN. Values of TDN in GBV (54.58%) were found to be less than those reported by Gupta *et al.* (1993) who reported that cull beans (*Phaseolus vulgaris*) contained 62% TDN. Preston, (2002) found that the artichoke tops contained 61% TDN which showed higher value than those recorded in this present study (49.54).

Regarding to DE values, results showed that DE had the same trend of significance as TDN for clover hay compared with other tested vegetable crops by-products materials. In this connection, Villamide *et al.*, (1998) reported that Lucerne meal had 7.4 MJ DE /kg. While, Stanton and Levalley (2007) found that pea vine hay had 1.18 Mcal / lb DE.

***Conclusively***, it could be concluded that these tested vegetable crop waste by-products (pea vines, Green bean vines and Squash vines) as compared with clover hay shows the possibility of using these feed materials as suitable non-conventional by-products in replacement of clover hay at certain levels in growing rabbit diets.

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# التقييم الغذائي لبعض مخلفات محاصيل الخضر كمواد علف غير تقليدية في تغذية الأرانب.

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الهدف من هذه الدراسة هو التقييم الغذائي لبعض مخلفات محاصيل الخضر( عروش الفاصوليا و البسلة و الكوسة و الكنتالوب و أوراق الخرشوف) كمواد علف غير تقليدية في تغذية الأرانب باستخدام الطرق الكيماوية و البيولوجية المختلفة و تتضمن التحليل الكيماوي وتقدير مكونات الألياف الخام و تقدير الأحماض الأمينية والمواد المثبطة للنمو و العناصر المعدنية. و أجريت سبع تجارب هضم غير مباشرة لتقييم معاملات هضم المواد الغذائية و حساب القيم الغذائية متمثلة في البروتين الخام المهضوم و المركبات الغذائية المهضومة و الطاقة المهضومة. تم استخدام عدد واحد و عشرون أرنب نيوزلندي ابيض ذكور بالغة عمر ٧ شهور ووزنها يتراوح ما بين ٢١٧٨ جم إلي ٢٢٢٧ جم وزعت عشوائيا إلي ٧ مجموعات كل مجموعة تتكون من ٣ أرانب.

النتائج المتحصل عليها تشير إلي أن عروش الكوسة سجلت أعلي محتوي من البروتين الخام (١٤,١٧%) يليها عروش البسلة (١٣,٧٩%) ثم عروش الفاصوليا (١٣,٤١%) ثم الدريس ١٣,٤٠% ثم عروش الكنتالوب (١٢,٥٧%) بينما سجلت أوراق الخرشوف اقل محتوي للبروتين الخام. عروش الكنتالوب سجلت أعلي محتوي في الألياف الخام (٣٠.٨٥%) و أقل محتوي كان لعروش البسلة (٢٣,٧٦%) بينما باقي المخلفات تقع بين المستويين. كان من الملاحظ أن دريس البرسيم و عروش البسلة وعروش الفاصوليا متقاربين في محتواهم من NDF وعروش الكوسة والفاصوليا والبسلة متشابهين في محتواهم من( ADF 32.30%، 33.20%، 34.50%). بينما تركيب الأحماض الأمينية يؤكد أن مخلفات محاصيل الخضر تفتقر إلي الأحماض الأمينية الكبريتية ( المثيونين و السيستين)، وغنية في محتواها من الأحماض الأمينية (الأسبارتيك و الجلوتاميك). تحتوي عروش الكنتالوب علي أعلي نسبة من الفينات يليها عروش البسلة ثم أوراق الخرشوف ثم عروش الفاصوليا، و يتراوح محتوي المخلفات من الأكسالات ما بين ٦.٢٤ % للأوراق الخرشوف إلي ١٠.٩٨ % للعروش الفاصوليا و كذلك عروش البسلة من أكثر المخلفات إحتواءا للصابونين (١٢.٧٠%).

و قد سجلت عروش البسلة وعروش الفاصوليا وعروش الكوسة أعلي القيم الغذائية متمثلة في البروتين الخام المهضوم و المركبات الغذائية المهضومة و الطاقة المهضومة و متقاربين للقيم الغذائية لدريس البرسيم.

من هذه الدراسة يتضح إمكانية استخدام عروش البسلة و عروش الفاصوليا الخضراء و عروش الكوسة محل الدريس كمواد علف غير تقليدية في تغذية الأرانب النامية.