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EFFECT OF FEEDING *HELIANTHUS TUBEROSUS* (*JERUSALEM ARTICHOKE*) ON RATIONS NUTRITIVE VALUE AND SOME BLOOD PARAMETERS OF OSSIMI RAMS

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SUMMARY

The present study was carried out at farm and laboratory of Animal Production Department- Faculty of Agriculture, Fayoum University, Egypt. *Helianthus tuberosus* in Ossimi rams rations were evaluated through digestibility, feeding values and some blood parameters. Ossimi rams weighed 45±5 kg in average were used to evaluate the rations supplemented by *Helianthus tuberosus*. The tested rations were D_1 (control) composed of 60% concentrate mixture (CM) + 40% wheat straw (WS); D_2, 52.5% CM + 7.5% *Helianthus tuberosus* (HT) +40% (WS); $D_{3,}$ 45% CM +15% HT +40% WS and $D_{4,}$ 30% CM +30% HT +40% WS. The results revealed that Ossimi rams fed rations of D_2 and D_3 showed higher significantly values (P<0.05) of most digestibility coefficients and feeding values compared with control ration. While, insignificant differences were found between D_1 and D_4 regarding digestibilities and feeding values. The obtained results of some blood parameters showed the same trend of rations digestibilities. Adding *Helianthus tuberosus* in the rations of D_2 and D_3 (7.5 and 15% HT) of Ossimi rams improved nutrients digestibility and feeding values and some blood parameters.

***Keywords**: Helianthus tuberosus, rams, digestibility coefficients, feeding values and blood parameters.*

INTRODUCTION

Helianthus tuberosus (Jerusalem artichok), a plant of the Asteraceae family that grows in cool to warm climates, also cultivated widely in China for its highly adaptability and multiple tuber usability options, and its tubers can be produced world-wide, including Asia, Europe, and North America. (Slimestad *et al.,* 2010 and Ma, 2011).

Helianthus tuberosus is a valuable fodder, technical and food culture that are becoming more widely used in various industries (Ryazanova *et al.*, 1997). Also, *Helianthus tuberosus* useful components intended for use as raw materials for foods. Powder *Helianthus tuberosus* flour contains complex carbohydrate components, represented mainly polysaccharide nature inulin (up to 82%), proteins (up to 7%), fat (0.3-0.7%), vitamins (B1, B2, C), pectin (10%), fiber (7%), organic acids, macro- and trace elements (Sidorenko and Gorshkov, 2003 and Liflyandskiy, 2006)

Helianthus tuberosus contains many compounds including coumarines, unsaturated fatty acid, polyacetylenic derivatives (Matsuura *et al.,* 1993) and sesquiterpenes (Baba *et al.,* 2005). Therefore, it has various pharmacological activities, such as cholagogue, aphrodisiac, aperient, stomachic, diuretic, and tonic effects. Also, its tuber, a potential source of biomass, is used as food and folk medicine for the treatment of diabetes and rheumatism due to the presence of inulin, which can be converted into fructose. Moreover, it was found that the extracts of the aerial part were also possess antifungal, antimicrobial, and anticancer activities. (Pan *et al.,* 2009) Additionally, *Helianthus tuberosus* leaf is a natural medicine for the treatment of skin wound, bone fracture and swelling. (Baba *et al.,* 2005).

Inulin and oligofructose are present naturally in several fruits and vegetables like Jerusalem artichoke, chicory, onion, garlic, banana and others. *Helianthus tuberosus* is a plant that can serve as an alternative source of carbohydrates. Certain dietary oligosaccharides, such as inulin and oligofructose, are considered as prebiotics and they are possible substitutes for antibiotics (Best, 2000). Other benefits noted with fructooligosaccharides (FOS) or inulin supplementation include increased production of beneficial short-chain fatty acids such as butyrate, Increased absorption of calcium and magnesium, and improved elimination of toxic compounds (Tomomatsu, 1994 and Van den Heuvel *et al*., 1999).

This study aimed to investigate the effect of partial replacement of concentrate mixture by *Helianthus tuberosus* in Ossimi rams ration on digestibility coefficient, feeding values and some blood parameters.

MATERIALS AND METHODS

The experiment was carried out at the Experimental Farm Station, Faculty of Agriculture, Fayoum University, Egypt to study the effect of supplementing *Helianthus tuberosus* replacement of concentrate mixture in ration of Ossimi rams on feed intake, nutrient digestibility, feeding values and some blood parameters.

Experimental animals

Twelve Ossimi rams weighted 45± 5 Kg in average were divided into 4 similar groups (3 rams each) and fed on the tested ration (Table 1). The tested rations were: the control ration (D_1) composed of 60% concentrate mixture (CM) plus 40% wheat straw (WS). Concentrate mixture were replaced by 12.5, 25 and 50% of *Helianthus tuberosus* (HT) on dry matter basis for D_2, D_3 and D_4, respectively. These replacements formed 7.5, 15 and 30% of the total rations dry matter for D_2, D_3 and D_4, respectively. Thus, four tested rations were performed.

Digestibility trial

Digestibility trial was carried out to evaluate the nutrients digestibility and nutritive value of the tested rations. The animals were individually placed in metabolic cage for 15 day as a preliminary period followed by 7 days as a collection period. The ration was offered daily and refused if found were recorded every day. Total feces were daily collected and weighted. Feces sample (10%) was taken, sprayed with 10% H_2SO_4 and dried at 60ºc for 24 hours, then it was ground and kept for chemical analysis. Samples of offered feeds were composite dried separately, finally ground and kept for chemical analysis according to the methods of the A.O.A.C. (1995). Gross energy (GE) and digestible energy (DE) of feeds were calculated after Nehring and Haenlien (1973).

Blood analysis

Blood samples were taken at the end of the digestion trail before the morning feeding from the jugular vein. The samples were directly collected into vacuum tube and centrifuged at 3000 rpm for 5 min. serum was separated into polypropylene tube and stored at -18 °C until analysis for total protein and albumin according to Weichselbaum, (1946) and Doumas *et al.* (1971), respectively. Globulin value was calculated by the differences between total protein and corresponding value of albumin. The total lipids was determined following method of Boutwell (1972), while cholesterol following Allain *et al.* (1974).

Statistical analysis

Data of the digestibility trial and some blood parameters were analyzed using general linear model procedure by computer program of SPSS (1997) and the differences between means were tested using Duncans new multiple test (Duncan, 1955). The statistical model was as follows: $Yij = m + Ai + eij$ Where Yij is dependent variable; m= overall mean; Ai= is the effect of treatment and eij= is the experimental error.

Table (1): Formula of the tested rations used in digestibility trial, on dry matter basis.

Item	Tested rations			
	D_1 (control)	D_2	D_3	D_4
Concentrate mixture*, %	60	52.5	45	30
Wheat straw, %	40	40	40	40
Helianthus tuberosus,%	--	7.5	15	30

** Concentrate mixture consisted of 22% soybean cake, 50% yellow corn, 10% rice bran, 10% wheat straw, 3.5 % molasses, 3% lime stone, 1% common salt and 0.5% minerals mixture.*

RESULTS AND DISCUSSION

Chemical composition of the tested ration

Chemical composition of concentrate mixture, wheat straw, *Helianthus tuberosus* and tested rations are presented in Table (2). *Helianthus tuberosus* was higher of nitrogen free extract (69.65%) compared with concentrate mixture which was 48.61%. Also, crude protein of HT was 9.8% which was nearly similar to yellow corn. Crude fiber of HT was very lower (4.14%) than concentrate mixture which 15.32% was. Ash of HT had the same trend of crude fiber but gross energy (GE) of HT was similar to concentrate mixture and wheat straw. Also, chemical composition of *Helianthus tuberosus* was nearly similar to yellow corn. Thus, has been replaced to concentrate mixture.

Table (2): Chemical analyses of ingredients and tested rations (on DM basis).

Item	DM%	% on DM basis						
		OM%	CP%	EE%	CF%	NFE%	Ash%	GE* Mcal/ kgDM
Concentrate mixture	91.44	84.09	16.54	3.62	15.32	48.61	7.35	3.84
Helianthus tuberosus	92.07	85.78	9.80	2.19	4.14	69.65	6.29	3.83
Wheat straw	91.54	79.81	3.89	1.85	33.42	40.65	11.73	3.81
D_1 (control)	91.48	82.38	11.48	2.91	22.56	45.43	9.10	3.84
D_2	91.53	82.50	10.97	2.80	21.72	47.00	9.02	3.83
D_3	91.57	82.63	10.47	2.70	20.88	48.58	8.94	3.81
D_4	91.67	82.89	9.458	2.483	19.21	51.738	8.78	3.78

**GE = tested diet three (30% concentrate mixture+40% wheat straw+30 Helianthus tuberous)*

Digestibility and nutritive values

The results in Table (3) showed that digestion coefficient of dry matter (DM%) was 58.83% in control diet (D_1) and was 63.04%, 62.08% and 59.31% of D_2, D_3 and D_4, respectively with significant differences ($P<0.05$). Organic matter (OM %) digestibility almost followed the same trend of DM digestibility. Digestion coefficient of crude protein (CP %) ranged between 58.52% and73.59% being significantly ($P<0.05$) higher in D_2 than those of D_4 and control one. Digestion coefficient of ether extract (EE %) was nearly similar to the trend of CP digestibility. Generally, ration D2 (7.5 % *Helianthus tuberosus) showed* the highest digestibilities of all nutrients especially when compared with D_1 (control ration) or D_4.

Table (3): Digestion coefficients and feeding values of the tested rations (on DM basis) fed to Ossimi rams.

Item	Tested Rations				± SE
	D_1 (control)	D_2	D_3	D_4	
Digestion coefficients %					
DM	58.83^{c}	63.04^{a}	62.08^{ab}	59.31^{bc}	± 0.651
OM	62.99^{c}	67.81^{a}	65.87^{b}	63.16^{c}	±0.685
CP	58.52^{b}	73.59^{a}	69.58^{ab}	59.53^{b}	±2.509
EE	75.44^{b}	79.85^{a}	77.91^{ab}	76.17^{ab}	±0.687
CF	52.68^{c}	59.00^{a}	56.45^{b}	51.51^{c}	±0.942
NFE	68.99^{b}	73.93^{a}	72.67^{a}	70.38^{b}	± 0.643
Feeding values					
TDN , %	54.88^{b}	60.67^{a}	59.10^{a}	56.17^{b}	± 0.312
DCP, %	6.72^{bc}	8.07^{a}	7.28^{ab}	5.63^{c}	± 0.312
DE (Mcal/KgDM)	237.59^{b}	263.61^{a}	248.73^{b}	261.82^{a}	± 3.499
GE (Mcal/KgDM)	384.43	382.80	381.27	378.05	± 0.709

Average in the same row with different superscripts are different (P≤0.05) for a,b and c.

These results were in agreement with those obtained by Swanson *et al.* (2002); Strickling *et al.* (2000) and Flickinger *et al.* (2003). Samal *et al.* (2017) showed that supplementation of *Jerusalem artichoke* (JA) to diets improved digestibility coefficient of CP, EE and CF when addition JA tuber powder (JA 0,2,4 and 6% pulverized) in rats and better absorption of calcium and phosphorus. Pradhan *et al.* (2015) observed a reduction in protein digestibility upon dietary supplementation with 2% of *Helianthus tuberosus* in the diet. Increased CF digestibility in *Helianthus tuberosus* -fed rams is in agreement with the findings of Zentek *et al.* (2002) and Samal *et al*. (2012) also recorded increased CF digestibility when *Helianthus tuberosus* was included in the diet.

Pawar (2007) and Kore *et al.* (2012) who used MOS as a prebiotic.The digestibility of CF was improved by dietary supplementation with *Helianthus tuberosus*. The increase in *Lactobacillus* spp. and *Bifido-bacterium* spp. populations by *Helianthus tuberosus* addition represents a clear improvement in the status of eubiosis. This may be the result of selective fermentation of inulin and fructooligosaccharides (FOS) by these beneficial bacteria in the hindgut.

Inulin-type fructans are either synthesized from sucrose or prepared commercially from inulin-rich plants such as chicory (*Cichorium intybusL.*) root and *Helianthus tuberosus* tuber. The yield potential, both for biomass and sugars, is higher in *Helianthus tuberosus* than chicory. The *Helianthus tuberosus* plant shows good frost and drought tolerance, is resistant to diseases and can achieve a high yield of biomass (Slimestad *et al.,* 2010). The inulin content in *Helianthus tuberosus* tuber ranges from 7 to 30% of fresh weight (Kays and Nottingham, 2007) or from 60 to 85.5% of dry weight (Aduldecha *et al.,* 2016). Tubers of *Helianthus tuberosus* have high metabolizable energy content of 15 MJ · kg−1 dry matter (Kleessen *et al*., 2007)

Some blood Parameters

The results of some blood constituents are shown in Table (4). The obtained values were in normal range. Concentration of total protein and albumin were significantly (P<0.05) higher in D_2 which consisted 7.5% *Helianthus tuberosus* than D_1 and D_3. No significant differences were found between D_2, D_3 and D_4 regarding globulin concentration. Meanwhile, D_2 and D_3 differed significantly (P<0.05) compared to D_1 (control ration). Concentration of cholesterol and creatinine were increased (P<0.05) significantly in D_1 (control diet) than the other diets. AST and ALT were not significantly different (P<0.05) among treatment. These results indicated that animals were generally in a good nutritional status and livers were in normal physiological conditions. Tiengtam *et al.* (2017) found that supplementation with inulin at 5g/kg or *Jerusalem artichoke*. While Nile tilapia diet it did not affect any significant changes in several blood metabolites, including glucose, cholesterol, triglyceride or albumin. A previous study in juvenile tilapia revealed that dietary inulin or *Jerusalem artichoke* had no effect on cholesterol or triglyceride; however, both increased glucose, plasma protein and albumin (Tiengtam *et al*., 2015). Such differences may reflect the effect of animal used or the level of *Helianthus tuberosus* in the ration.

Table (4): Some blood parameters of tested diets (on DM basis) fed to Ossimi rams.

Item	Tested rations				± SE
	D_1 (control)	D_2	D_3	D_4	
Total protein(g/dl)	5.72^{b}	6.91^{a}	5.57^{b}	6.48^{ab}	0.201
Albumin(g/dl)	2.93^{c}	3.49^{a}	3.17^{b}	3.20^{b}	0.063
Globulin(g/dl)	3.19^{b}	3.55^{a}	3.60^{a}	3.27^{ab}	0.067
Cholesterol(mg/dl)	98.40^{a}	94.57^{bc}	93.48^{c}	96.91^{ab}	0.683
Triglycerides(mg/dl)	51.07^{a}	50.14^{bc}	49.83^{c}	50.71^{ab}	0.172
Creatinine (mg/dl)	1.20^{a}	1.13^{ab}	1.04^{b}	1.11^{ab}	0.023
ALT (u/ml)	28	27	27	28	0.328
AST(u/ml)	43	40	41	42	0.835

Average in the same row with different superscripts are different ($P \leq 0.05$) for a,b and c.

The *Helianthus tuberosus* addition into diets significantly ($P \leq 0.05$) increased total short-chain fatty acids concentrations as the level of Jerusalem artichoke in the diet increased. Also, lactic acid content was increased and ammonia concentration was reduced in feces due to *Helianthus tuberosus* supplementation (Samal *et al*., 2017). These findings may suggest the obtained results of total protein and triglycerides.

CONCLUSION

Supplementing *Helianthus tuberosus* to the ration of Ossimi rams as replacement with 7.5% and 15% improvement nutrient digestibility, feeding values and some blood parameters. Also, more researches were needed to examine different levels of *Helianthus tuberosus* in the diets with different animal types.

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تأثير التغذية بدرنات نبات الطرطوفة علي القيمة الغذائية وبعض مقاييس الدم للأغنام الأوسيمي

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أجريت هذه الدراسة بمزرعة ومعمل قسم الإنتاج الحيواني - كلية الزراعة - جامعة الفيوم - مصر. وتم فيها تقييم درنات نبات الطرطوفة المضافة إلي علائق الكباش الأوسيمي من خلال معاملات الهضم والقيم الغذائية وبعض مقاييس الدم.

إستخدام في هذه الدراسة 12 كبش يتراوح وزنها 45 ± 5 كجم في المتوسط، تم استخدامها لتقييم العلائق المحتوية علي درنات نبات الطرطوفة وكانت العلائق المختبرة كالتالي: غذيت المجموعة الأولي D_1 (المقارنة) على عليقة مكونة من60% خليط مركز +40% تبن قمح، وغذيت المجموعة الثانية D_2 علي 52.5% خليط مركز+ 7.5% درنات نبات الطرطوفة +40% تبن قمح، أما المجموعة الثالثة D_3 فغذيت علي 45% خليط مركز +15% درنات نبات الطرطوفة +40% تبن قمح، بينما غذيت المجموعة الرابعة D_4 علي30% خليط مركز +30% درنات نبات الطرطوفة+40% تبن قمح وقد أظهرت النتائج ما يلي:

معاملات هضم المادة الجافة، المادة العضوية، البروتين الخام، الألياف الخام، الدهن الخام، الكربوهيدرات أظهرت قيمًا معنوية ($P<0.05$) أعلى في العلائق المحتوية علي 7.5% ،15% درنات نبات الطرطوفة مقارنة بالعليقة المقارنة والعليقة D_4 التي تحتوي علي 30% درنات نبات الطرطوفة.

اضافة درنات نبات الطرطوفة أدي إلي تحسين المركبات المهضومة الكلية والبروتين الخام المهضوم تحسين معنوي ($P < 0.05$) في العليقة D_2، D_3 والمحتوية علي 7.5% ،15% درنات نبات الطرطوفه مقارنة بالعليقة المقارنة و العليقة الرابعة D_4. النتائج التي تم الحصول عليها من بعض مقاييس الدم أظهرت زياده معنوية ايضا في البروتين الكلي، الالبيومين ، الجلسريدات الثلاثية في العليقة الثانية D_2 والمحتوية علي 7.5 % درنات نبات الطرطوفة بالمقارنة بالعلائق الأخرى ، أما بالنسبة للكوليسترول والكرياتينين كانت العليقة الأولي (المقارنة) D_1 أكثر العلائق معنوية عن باقي العلائق الأخرى. اما انزيمات الكبد فكانت غير معنوية.

نستخلص من هذه الدراسة أن إضافة درنات نبات الطرطوفة إلي علائق الأغنام الأوسيمي بنسبة 7.5% ، 15% من العليقة أدت إلي زياده معدلات هضم المركبات الغذائية وزياده معدل الاستفادة من بروتين العليقة ولم تؤثر علي صحة و نشاط الحيوان.