

POTATO BY – PRODUCTS AS ANIMAL FEED : 4 – EFFECT OF SOLANINE ON MINERALS AND VITAMINS IN SHEEP DIETS .

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ABSTRACT

The objective of the present study was to assess the potential effects of solanine in potato by-products (PB-P) on minerals and vitamins utilization and nitrogen retention . Nine Rahmany rams at 3 years of age , 70.35 kg body weight divided into three groups three animals each their assigned to three digestion trials with three experimental rations . The experimental diets were consists of 50 % concentrate feed mixture (CFM) + 50% roughage as well as berseem hay in control ration , potato by-products silage (PB-PS) and potato by-products hay (PB-PH) in second and third rations , respectively . The results indicated that the DMI of potato by – products silage (PB-PS) was higher than another tested treatments . Daily solanine dose is higher ($p < 0.05$) in potato by – products hay (PB-PH) compared to PB-PS group . Some measures were taken on rations , blood , faeces and urine to determine the minerals and vitamins quantities . The results showed that the nitrogen intake was lower in BP-PH than control and BP-PS . Whereas nitrogen excretion was the highest in control and BP-PH groups than BP-PS group and the differences were significant ($p < 0.05$) . However , nitrogen balance was higher with BP-PS ration more than another experimental groups . The minerals as well as calcium , phosphorus , magnesium , sodium , iron , manganese , zinc and potassium were significantly ($p < 0.05$) higher in PB-PS compared to PB-PH and control group , except for the potassium intake in was lower in PB-PS than other test groups , these results was almost similar to those obtained in blood serum . However , the mineral balance as well as , calcium , magnesium , sodium , iron , manganese , zinc and potassium of PB-PS were significantly ($p < 0.05$) higher than those of PB-PH and control diets .Whereas it was lower in phosphorus content compared to PB-PH group . The mineral intake as well as calcium , phosphorus , magnesium , sodium , manganese , zinc and potassium were significantly ($p < 0.05$) lower in PB-PS than another groups , except of iron is higher in PB-PS than others . Whereas minerals balance of PB-PH were higher significantly ($p < 0.05$) in magnesium , zinc and potassium than PB-PS , but it was lower in another elements . The results indicated that the vitamins intake as well as B1 , B3 , B6 and C are significantly ($p < 0.05$) lower in PB-PS , except B2 is higher, than PB-PH and control groups . Serum blood of PB-PS were significantly ($p < 0.05$) lower of all vitamins , except of vitamin B3 is higher. All vitamins serum blood of control group were significantly ($p < 0.05$) higher than other groups .

Keywords : Solanine , Minerals , Rahmany rams , Potato by-products, Silage, and Hay

INTRODUCTION

Potato contains a number of important minerals and vitamins . hundred and fifty gm of potato provides 27 mg vitamin C, 620 mg of potassium , 0.2 mg vitamin B6 and trace amounts of thiamin, riboflavin , folate, niacin , magnesium , phosphorus , iron , and zinc. In addition , potato also contains an assortment of phytochemicals , such as carotenoids and polyphenols . Such potato by products offer an excellent feed source in nutrition (Gull *et al* ., 1970) . Peeled, long - stored potatoes have less nutritional value, although

they still have potassium and vitamin B . Low fecal excretions of calcium, magnesium, phosphorus, and sulfur resulted in positive balances for these minerals .Calcium balance was more positive when subjects received the pinto bean diet, which also supplied more lysine and calcium than the other diets. Abd El hamid *et al .*, (1999 a and b) reported that Zariby goats had being 8.13 – 8.29 mg Ca / dl, 3.45-4.31 mg P /dl, 2.69 – 3.63 mg Mg /dl and 60.8 – 96.2 µg Fe / dl . It is suggested that one aspect of the mechanism of metabolic adjustment to low protein intake involves greater contain glycoalkaloids, toxic compounds, of which the most prevalent are solanine at high temperatures (over 170 °C) partly destroys these. Glycoalkaloids retention of dietary sulfur, greater conservation of absorbed sulfur, and a reduction in the catabolism of sulfur-containing amino acids.(Edward *et al .*, 1972) . Potatoes occur in the greatest concentrations just underneath the skin of the tuber, stem and they increase with age and exposure to light . Solanine may cause headaches, diarrhea, cramps and in severe cases coma and death . However , poisoning from potatoes occurs very rarely. Light exposure also causes greening . Breeders try to keep solanine levels below 2 mg / kg body weight . The National Toxicology Program suggests that the average american consumes at most 12.5 mg /person/day of solanine from potato . Saleh *et al .* (2007) found that solanine in potato by-products had effective harmful and toxicity effects . However,feeding common potato led to solanine toxicity and affected performance of starter, growing and finishing pigs (Patil *et al .*,1972) . Jadhav *et al .*(1981) found natural occurring toxic alkaloids in potatoes by - products . Morris and Lee (1984) and Renwick *et al .* (1984)detected solanine embryotoxicity and teratogenicity , as well as inhibition of rat cholinesterase isoenzymes *in vitro* and *in vivo* by the potato alkaloid . Alozie *et al .* (1978) found that the amount of solanine was about 0.01 – 0.1 % of potatoes dry matter . Solanine is also found in other plants, including the potato and dangerous plants like tobacco.

The main objective of the present study was aimed to investigate the harmful effect of solanine in potato by-products silage (PB-PS) and potato by-products hay (PB-PH) on minerals and vitamins utilization .

MATERIALS AND METHODS

This experiment was carried out in El - Serw Animal Production Research Station , Animal Production Research Institute , Agriculture Research Center, through the year 2005. Aimed to investigate the effect of solanine in potato by-products on minerals and some vitamins utilization . Three treatments with three rams in each with an average body weight of 70 . 35 kg and 3 years of age were used in this study . Rams were housed in groups and kept under shade . The feeding system was 50 % concentrate + 50 % roughage , as berseem hay in CB or potato by product in the form PB-PS and PB-PH . The PB-PS is consists of potato vine , greenish spots and small damage tubers which , supplemented with 5% molasses + 3 % urea . Feed was offered twice daily at 8 am and 3 pm. Feed intake and faeces weight were recorded and collected daily in plastic bags from each ram .The collection period was 7days following a 2-weeks as preliminary period .

Urine was measured daily and collected after diluted with 20 ml of conc.sulfuric acid to kept ammonia until nitrogen determination . Minerals were determined in feed , faeces and urine . Amino acids were determined in feeds also . The solanine was determined quantitively in potato silage , potato hay , faeces and urine .

Chemical analysis :

Composite samples were prepared for chemical analysis . Faeces samples were analyzed according to A.O.A.C (2000) . Minerals as well as Ca was determined according to Elvebach (1970) , P according to Freidman *et al* ., 1980) , Mg according to Oranye and Rhein (1951) and Iron according to Meites (1977) . Whereas the vitamins were determined according to A.O.A.C. (2000). Amino acids were determined by amino acid analyzer at Food and Feed Laboratory Center according to Kofranyi and Jekat (1964). Solanine was determined according Bushway and Ponnampalam (1985) .

Statistical analysis:

Data were analyzed using the general linear model procedure of SAS (1996). The significant differences among means were determined by the new multiple rang test (Duncan ,1955) .

RESULTS AND DISCUSSION

Chemical analysis and nutritive values of rations , solanine and amino acids are presented in Table (1) .

Table 1 : Chemical analysis of feed ingredients and experimental Rations , nutritive values and solanine e content in ration fed by Rahmany rams (%on dry matter basis) .

Item, %	DM	OM	CP	CF	EE	ASH	NFE
feed ingredients							
CFM	90.13	89.70	14.88	13.40	3.10	10.30	58.92
CB	88.58	89.22	13.94	14.09	2.85	10.78	58.34
PB-PS	87.34	90.24	12.30	11.48	3.46	9.76	63.00
PB-PH	89.72	89.57	11.59	17.55	2.76	10.43	57.76
Nutritive values							
	Control		PB-PS		PB-PH		
DMI (kg / h/ d)	2.68b		2.85a		2.79b		
TDN(g / h/ d)	62.78		65.43		63.21		
DCP (g / h/ d)	11.25		11.20		10.53		
Water consumption (g /h/d)	3250c		2870a		3510b		
Solanine content (mg1 /00 gm)							
	PB-PS			PB-PH			
Diet	133.88b			382.51a			
Faeces	39.80b			71.93a			
Urine	28.47b			58.21a			

Means having different superscripts within the same row are significantly different at P<0.05 .

CFM = concentrate feed mixture , PB-PS = potayo by –products silage , PB-PH = potayo by –products hay

Amino acid content :

Amino acids % in rations are presented In Table (2), the results clearly that PB-PS was higer of amino acids than PB-PH and control groups .

Table 2 : Amino acids conten(%) in the experimental rations .

Amino acid	Expermintal diets		
	Control	PB-PS	PB-PH
Alanine	4.10	4.56	3.90
Argnine	3.70	4.29	2.00
Aspartic acid	5.30	18.78	4.40
Cystine	0.50	4.93	0.70
Glutamic acid	9.15	12.10	11.40
Glycine	4.55	4.12	3.80
Histiden	1.10	1.97	1.20
Leucine	7.23	5.24	3.10
Iso leucine	4.37	4.86	2.60
Lysine	0.60	3.42	1.60
Methionine	2.20	2.33	3.00
Phenyle A.	3.71	5.11	3.80
Praline	1.05	2.03	0.40
Serine	1.50	2.19	1.10
Therionine	0.26	2.31	0.40
Treptophane	4.17	3.70	5.30
Tyrosine	1.60	2.09	1.30
Valine	4.98	5.85	4.50

Nitrogen retaintion :

Results of nitrogen retention of rams fed on expermintal rations is presented in Table (3) . Nitrogen intake was lower in BP-PH than control and BP-PS groups. Nitrogen balance was higher with BP-PS ration more than another expermintal groups . Resultats indcated that silage process improved nitrogen balance as a percentage of intake (29.43 , 21.46 and 21.41 % for BP-PS , BP-PH and control , respectively) . This result is agreement with the finding of Saleh *et al.* (2007a) .

Table (3) : Nitrogen balance of rams fed on potato by - products silage or hay.

Items	Control	PB-PS	PB-PH
Nitrogen balance mg / kg BW	850a	802b	736c
Total nitrogen excretion mg / kg BW	668a	566b	587c
Digestable nitrogen mg / kg BW	528a	525a	462b
Nitrogen balance mg / kg BW	182a	236a	149b
Nitrogen balance of Nitrogen balance %	21.41 ^b	29.43a	21.46 ^b

means in the same rows were superscripted by differletter significantly (P<0.05) .

Minerals intake :

Data in Table (4) indicated that minerals intake had variation values and significant diffrences among treatments, particularly was the poptato by - products silage (PB-PS) . It had significantly (p < 0.05) higher intake in all tested minerals than those of control (CB) and potato by-products hay (PB-

PH) , except of potassium in potato by-products hay group which was significantly ($p < 0.05$) higher when compared to other groups. These results may be due to molasses supplemented to silage through the silage making or to the increase of solanine level in PB-PH diet .

Table (4) . Minerals intake mg /h /d of experimental diets of rams fed on potato by - products as silage or hay .

Items	Control	PB-PS	PB-PH
Calcium	4788.4b	5630a	4452b
Phosphorus	3015.5b	3782a	2867c
Magnesium	3359.2b	3867a	3241b
Sodium	5376.0b	6738a	4298c
Iron	2432.7b	4753a	1730c
Manganese	720.3b	911a	531c
Zinc	170.5b	217a	180b
Potassium	215.4b	447b	490a

Means having different superscripts within the same row are significantly different at $P < 0.05$.

Blood minerals :

The results clearly that minerals in blood as well as calcium , phosphorus , magnesium, sodium, iron, manganese , zinc and potassium in PB-PS were significantly ($p < 0.05$) higher than PB-PH and control group , except of potassium intake which was lower in PB-PS than other groups . Abdelhamid *et al .* , (1999 a & b) reported nearly similar values for Zaribi goats .

Table (5) . Some minerals (mg/100ml). in blood of rams fed on potato by – products Silage or hay treatment.

Blood minerals	Control	PB-PS	PB-PH
Calcium	9.62b	10.21a	8.04b
Phosphorus	5.48b	7.66a	4.21b
Iron	79.51b	98.78a	81.35b
Magnesium	3.92b	4.38a	5.06a
Sodium	9.85	12.79	10.41
Manganese	2.18	2.57	2.98
Zinc	1.76	1.34	1.85
Potassium	7.38	8.97	10.44

Means in the same rows were superscripted by different letters significantly ($P < 0.05$) .

Minerals excretion :

The faeces and urine minerals are presented in Table (6) . Results showed that minerals excretion of PB-PS significantly ($p < 0.5$) higher when compared with those obtained from PB-PH and control group. While minerals excretion of PB-PH group was significantly lower ($p < 0.05$) than PB-PS and control one , except for total potassium excretion in PB-PH was more higher than PB-PS and control group . These results agreed with Hoek *et al .* , (1988) who reported that calcium concentration , calcium : phosphorus (Ca : P) ratio and magnesium were effected on mineral balance. The urinary

excretion of P decreased with increasing dietary Ca and increased with increasing P intake in rats .

Table (6) . Mineral excretion in faeces and urine of Rahmany rams fed on potato by- products as silage or hay , mg /h /d .

Items		Control	PB-PS	PB-PH
Calcium	Faeces	2059b	2533a	1825c
	Urine	50b	64a	50b
Phophorus	Faeces	1296b	1672a	1031c
	Urine	35a	31b	30b
Magnisium	Faeces	1481b	1764a	1450b
	Urine	38b	40a	35c
Sodium	Faeces	2296b	3005a	1801c
	Urine	58a	62a	44b
Iron	Faeces	1050b	2106a	975c
	Urine	28b	51a	21b
Manganis	Faeces	188b	316a	134c
	Urine	27b	38 a	19c
Zink	Faeces	58a	69a	37b
	Urine	12b	16a	11b
Potasium	Faeces	59b	87a	70b
	Urine	15b	20a	15b

Means having different superscripts within the same row are significantly different at $P < 0.05$

Minerals balance :

Calcium , magnisium , sodium , iron , manganis , zink and potasium balances for PB-PS group were significantly ($p < 0.05$) higher than those of PB-PH and control diets , whereas it was significantly lower in phosphorus when compared to PB-PH group . On the other hand the % of minerals intake as calcium , phophorus , magnisium, sodium, manganis , zink and potasium were significantly ($p < 0.05$) lower in PB-PS than another groups , except of iron was higher in PB-PS than others . Whereas minerals balance of PB-PH were higher significantly ($p < 0.05$) of Magnisium, zink and Potasium than PB-PS and lower in another elements (Table, 7) .The results are in agreement with Hoek *et al.*, (1988) .

Vitamins in diets and blood :

Data in Table (8) clearly showed that intake of vitamin B1 (thiamin) , B3 (cicine) , vitamin. 6 and vitamin . C of control group was significantly ($p < 0.05$) higher compared to PB-PS and PB-PH groups, whereas the same group is lower in riboflavin (Vit. B2). This result indicated that vitamin B1 is affected by level of solanine in diet .This is agrees with Saleh *et al.* , (2007) who reported that the solanine in potatoes by – products is more harmful effects on both humen and animals . Also, the results indicated clearly that PB-PS is higher in its contain of riboflavin (Vit. B2) . Saimillar result was obtained to Vitamin C . While PB-PS was significantly ($p < 0.05$) higher in all vitamins than PB-PH group .

Table (7) . Mineral balance , (mg / h / d) and % of intake of rams fed potato by- products as silage or hay .

Items		Control	PB-PS	PB-PH
Calcium	Balance	2680b	3033a	2577b
	% of intake	56a	54b	58a
Phosphorus	Balance	1684b	2079a	1806b
	% of intake	56b	55b	63a
Magnesium	Balance	1840c	2063b	2115a
	% of intake	55b	53b	62a
Sodium	Balance	3022c	3672a	2453b
	% of intake	56a	55b	57a
Iron	Balance	1353b	2597a	734c
	% of intake	56a	55a	42b
Manganese	Balance	507a	557a	377b
	% of intake	70a	61b	71a
Zinc	Balance	110b	132a	132a
	% of intake	65b	624c	74a
Potassium	Balance	142b	340a	355a
	% of intake	66c	76b	82a

Means having different superscripts within the same row are significantly different at $P < 0.05$.

Table (8) . Some vitamins in diets and blood mg / 100gm or 1 ml. of rams fed on PB-PS and PB-PH mg / 100gm

Items		Control	PB-PS	PB-PH
Thiamin (Vit. B1)	diets	2314.3a	2712.4 b	1998.7c
	Blood	24.58a	19.33b	14.98c
Riboflavin (Vit.B2)	diets	0.43c	0.67a	0.59a
	Blood	0.091a	0.078b	0.053c
Niacin (Vit. B3)	diets	34.7a	23.39b	26.16b
	Blood	8.49a	7.21A	5.69b
Vitamin B6	diets	8.26a	6.35b	5.03b
	Blood	2.94a	1.67b	1.49b
Vitamin C	diets	653.4a	595.6b	488.6c
	Blood	13.58a	10.69b	8.11b

Means having different superscripts within the same row are significantly different at $P < 0.05$.

CONCLUSION

This study indicated that minerals in potato by-products silage or hay were significantly affected by solanine in diets.

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مخلفات البطاطس كغذاء حيواني :

4 - تأثير السولانين في مخلفات البطاطس على الإستفادة من بعض المعادن و الفيتامينات في علائق الاغنام .

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تم استخدام 9 كباش رحمانى بمتوسط وزن 70.35 كجم عند عمر 3 سنوات بمحطة التجارب والبحوث بالسرو لدراسة تأثير سيلاج ودريس مخلفات البطاطس على والاستفادة من المعادن والفيتامينات فى الغذاء. قسمت الكباش عشوائيا إلى ثلاثة مجاميع , المجموعة الأولى وغذيت على العلف المركز +50 % دريس برسيم , المجموعة الثانية غذيت سيلاج مخلفات البطاطس (عروش ودرنات) + 5% مولا س +3% يوريا , المجموعة الثالثة غذيت على دريس مخلفات البطاطس (عروش ودرنات) . وتم تقدير والسولانين والنيتروجين و المعادن فى الغذاء و فى الروث والبول لتقدير المحتجز فى الجسم و كذا فى العلائق , وقد أظهرت النتائج أن المادة الجافة المأكولة والأحماض الأمينية فى المعاملة التى تغذت على سيلاج مخلفات البطاطس كانت أعلى مقارنة بالمعاملات الأخرى , كما أوضحت النتائج أن الجرعه اليوميه من السولانين كانت مرتفعه بفرق معنوى (0.05) للمعامله التى تغذت على دريس مخلفات البطاطس عنه فى السيلاج . وكانت % للنيتروجين المحتجز الى المأكول بالمعدلات الآتية 29.43 , 21.46, 21.41 % لكل من السيلاج ودريس البطاطس ومجموعة المقارنه على التوالى . أما المعادن فقد وجد أن المعادن فى الغذاء المأكول كانت أعلى فى السيلاج عن باقى المعاملات التجريبيه فيما عدا البوتاسيوم الذى كان منخفضا وان النتائج التى تحصل عليها تتناسب تماما مع المتحصل عليها من المعادن فى سيرم الدم , ومع ذلك فاعن المعادن المحتجزه كالكالسيوم والماغنسيوم والحديد و المنجنيز والزنك والبوتاسيوم فى السيلاج كانت أعلى معنويه عند مستوى 0.05 مقارنة بالدريس و مجموعة المقارنه بينما كان منخفضا فى الفسفور بالنسبه إلى مجموعة دريس البطاطس , فى نفس الوقت فاعن % للمأكول من المعادن كالكالسيوم والفسفور والماغنسيوم والصوديوم و المنجنيز والزنك والبوتاسيوم كانت منخفضة معنويا عند مستوى 0.05 فى المجموعه التى تغذت على السيلاج ماعدا الحديد فكان مرتفعا فى مجموعة السيلاج مقارنة بالمجاميع الأخرى . أما المنجنيز والزنك والبوتاسيوم المحتجز كان أعلى فى مجموعة الدريس عن مجموعة السيلاج وانخفضت فى العناصر الأخرى , كما أوضحت النتائج أن المأكول من الفيتامينات مثل فيتامين ب1 وب3 وب6 وفيتامين س C كانت منخفضة بمعنوية 0.05 فى السيلاج بينما كان فيتامين ب 2 بها مرتفعا مقارنة بمجموعتى الدريس والمقارنه , فى نفس الوقت كانت كل الفيتامينات فى مجموعة السيلاج منخفضة معنويا , ماعدا فيتامين ب 3 الذى كان مرتفعا بينما أعطت مجموعتى السيلاج و الدريس أقل قيمة لفيتامين B6 بالنسبه لمجموعة المقارنه .

نستخلص من هذه الدراسه ان للسولانين تأثير على الاستفادة من الاملاح المعدنيه بدرجة كبيره , بينما لم يظهر هذا التأثير مع الفيتامينات فى كل من سيلاج ودريس مخلفات البطاطس .