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POTATO BY – PRODUCTS ASANIMAL FEED: 3 – SOLANINE AND IT'S EFFECTS ON MICROORGANISMS ACTIVITIES AND SOME RUMMEN PARAMETERS .

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ABSTRACT

This study was conducted to investigate the effect of solanine in potato by - products as silage or hay on microorganisms activities and some another parameters in Rahmany rams . Nine adult rams with an average body weight of 70.35 kg and 3 years of age were randomly divided into three groups , 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 digestion trials was lasted for 4 weeks .The obtained results showed that PB-PS diet was significantly lower ($p < 0.05$) in crude fiber , and higher in crude protein (CP) and ether extract (EE) compared to the another treatments . On the other hand the higher values of crude fiber and solanine were found in PB-PH diet value of NDF, ADF, ADL , cellulose and hemicelluloses were significantly ($p < 0.05$) decreased in PB-PS , whereas this values were increased in PB-PH and control diet .The higher values of acetate , Butrtate , Iso – Butrate were detected in PB-PH , whereas the PB-PS diet recorded higher value of propionate and valerate , and lower value of A : p ratio compaered to control treatment . Both of ammonia –N and VFAs in rumen liquor were higher significant ($p< 0.05$) in silage group followed by PB-PH and control group through different times .The total bacterial count and cellulebacterial and protozoal were significantly higher ($p < 0.05$) . in PB-PS at 0 , 3 and 6 hrs after feeding . On the other hand PB-PH was lower in RBC and Monocyte while it was higher in PB-PS and control groups . Neutrophile , WBC, Eiosinophile , Lymphocyte . were significantly higher ($p < 0.05$) for PB-PH compared with PB-PS and control groups .

Keywords: Solanine , Potato by-products , microorganisms activities , Another rumen parameters .

INTRODUCTION

Solanine in potatoes may induce gastro-intestinal and systemic effects, by cell membrane disruption and acetyl cholinesterase inhibition, respectively. The present single dose study was designed to evaluate the toxicity and pharmacokinetics of orally administered potato α-solanine .The first published human volunteer study were obtained for more than 24 h post-dose. In one study they were received one of the following solanine doses of 0.30, 0.50 or 0.70 mg/kg body weight , mashed potatoes with solanine doses of 0.95, 1.10 or 1.25 mg / kg BW. The mashed potatoes had a solanine concentration of nearly 200 mg / kg fresh weight (the presently recognized upper limit of safety). None of these treatments induced acute systemic effects. One subject whose received the highest dose of α-solanine (1.25 mg/kg BW) became nauseous and started vomiting about 4 h post-dose, possibly due to local α-solanine toxicity (although the doses is lower than generally reported in the literature to cause gastro-intestinal

disturbances). Most relevant, the clearance of α-solanine usually takes more than 24 h, which implicates that the toxicants may accumulate in case of daily consumption. Saleh *et al* (2007) found that solanine in potato by –products cause decrease in both milk yield , growth performance of growing lambs . Solanine contents in potatoes are potentially toxic, so there is a strong need for a method to control stressed potatoes and to monitor the potato transgenic cultivars, which requires the screening of many samples. This paper describes a new assay method for α-solanine detection in the leaf, sprout, skin and tissues of different potato cultivars.

The main objective of the present study was to evaluate the effect of solanine residues in both potato by- products silage (PB-PS) and potato by-products hay (PB-PH) on nutrient digestibility, some blood and rumen parameters comparable with concentrate feed mixture (CFM) + berseem hay (CBH).

MATERIALS AND METHODS

This study was carried out in El -Serw Animal Production Research Station , Animal Production Research Institute , Agriculture Research Center , Ministry of Agriculture , through the year 2005 .

Animals feeding and management :

Nine (3 years old) Rahmany rams were used in this study Animals were divided according to their body weight into three comparable groups , (3 animals in each) . Average body weight was 70.35 ±1.7kg for the three groups.Three digestible trials were carried out, The animnals were fed according to NRC (1990) as following , the first group fed 50 % concentrate + 50 % berseem hay as a control , second group fed 50 % concentrate + 50 % potato by –products silage (PB-PS) and third group fed 50 % concentrate + 50 % potato by –products hay (PB-PH) . Rams were housed and fed individually and kept under shade .

Samples :

- Faeces and urine collection :

The collection period was 7days following a two weeks as preliminary period . Feed allowances were offered at 8.00 am and 3 pm . Faeces samples were collected quantitively daily during the collection period , Also the urine was collected after diluted with 20 ml of conc. sulfuric acid to kept ammonia until nitrogen determination . Feed and faeces were dried in a forced air oven , ground and kept for later analysis .

- Silage making :

Whole green potato fresh aerial parts in addition to small infirmity and greenish spots tubers from *Solanum tuberosum* were chopped manually using knives, then wilted by spreading under direct sun for a day thin mixed with wheat straw : potatoes by – product (4 :1 ratio) + 5% molasses+ 3 % urea and ensiled in white plastic bags for 2 month before feeding . After ensilage period , the color and odor were examined and samples were taken for chemical analysis, solanine was determined and silage quality test was performed .

- Hay making :

Also green potato fresh aerial parts and small infirmity and greenish spots tubers from *Solanum tuberosum* were wilted by spreading under direct sunshine until complete drying , then packed in white bags .

- Rumen liquor :

The rumen liquor was collected from each animal using stomach tube, before feeding and at 3 and 6 hrs post feeding . Ruminal pH was measured immediately after collection using digital pH meter (mode HI 8424) .Rumen fluid was strained through three layers of cheesecloth into plastic containers and kept in refrigerator at 4 °C Ruminal total volatile fatty acid (TVFA) concentration were determined according Warner (1964), while proportion of VFA were determined according to Erwin *et al* . (1961) . Ammonia nitrogen (NH3 – N) concentration were determined as described by Conway (1958) .

- Blood :

Blood samples were withdrawn from the lift jugular vein of all animals before feeding and at 3 and 6 hrs .It collected into tubes with anticoagulant for determination of the total Neutrophile , Lymphocyte , Monocyte and Eiosinophile on blood film stained with wrights stain according to Coles (1986). Whereas red and white blood cells were determined according to Miller and Weller (1971) in whole blood .

- Proximate analysis :

Proximate analysis of feeds and faeces were carried out according to A.O.A.C. (2000) for dry matter (DM) , organic mater (OM) , crude protein (CP) ,and ether extract (EE).Solanine was determined according to Bushway and Ponnampalam (1985) .

- Rumen microorganisms count :

Direct microscopic counts of bacteria was determined according to Warner (1962) . Enumeration of cellulolytic bacteria was determined according to Mostpropable – Number producers as described by Mann (1968) . Total protozoa count were determined according to the methods discriped by Abou – Akkada *et al.* (1969) .

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 composition of experimental diets :

Table (1) presented the chemical analysis of experimental diets and feed ingredients .Crude protein (CP) was lower in potato by-products hay(PB-PH), whereas crude fiber (CF) was higher in berseem hay and potato by-products hay (PB-PH) On the other hand nitrogen free extract (NFE) was lower in berseem hay,while poptato by-products silage (PB-PS) was higher in NFE . These results are in agreement with Abdelhamid *et al* , (1992) who reported that there were variations in the chemical composition of diffrent agriculture wastes . These variation were found too in their digestibilities and mineral content .

Table (1) .Chemical analysis (%on DM bases) of feed Ingredients and experimental rations

Items	Feed ingredients			
	C FM	**BH**	**PB-PS**	**PB-PH**
OM	89.70	88.58	86.23	88.49
CP	14.88	14.16	13.08	11.89
CF	13.40	25.14	14.2	17.55
EE	3.10	2.59	3.48	2.86
Ash	10.30	11.42	13.77	11.51
NFE	58.92	46.69	55.47	56.29
	Experimental rations			
	Control		PB-PS	PB-PH
OM	89.22		90.24	89.57
CP	13.94		12.30	11.59
CF	14.09b		11.48c	17.55a
EE	2.85b		3.96a	2.76b
Ash	10.78		9.76	10.43
NFE	58.34b		61.10a	57.82b

Means having different superscripts within the same row are significantly different at P<0.05 .
CFM = Concentrate feed mixture , BH = berseem hay
PB-PS = Potato by-products silage , PB-PH = Potato by - products hay

Solanine residues :

The results presented in Table (2) explained solanine levels in PB-PS, PB-PH and faeces. Solanine level in potato by –products hay was high in both diet and faeces and significantly (P < 0.05) increased than in those potatoes silage .The average daily does was 133.88 and 382. 51 mg for both PB-PS and PB-PH, respectively . On the other hand, the faeces showed the same trend and the values were 40.33 and 121.38 mg respectively .This reduction of solanine in silage may be due to the action of ensilage process.The results agreed with Alozie *et al* . (1978) . who observed inhibition of cholinesterase iso enzymes *in vitro* and *in vivo* by the potato - solanine . Gull *et al* .(1970) and Dalvi and Bowie (1983), reported that solanine is a toxic glycoalkaloid in *Solanum tuberosum*, it deffects the protein digestibility and growth performance .Whereas Hansen (1925) found two fatal cases of potato poisoning. Swinyard and Chaube, (1973) and Chaube and Swinyard (1976) reported that solanine is teratogenic and toxicological phenolic compound .

Table (2) . Solanine determined in PB-PS, PB-PH rations and feces of Rahmany rams mg / h / d.

Items	Solanine mg/h/d	
	PB-PS	**PB-PH**
rations	133.88b±2.37	382.51a±5.15
Feces	40. 33b±0..94	121.38a±3.76

Means having different superscripts within the same row Are significant

Feed intake :

Data of the feed intake of group fed berseem hay as control or other experimental groups fed PB–PS or PB-PH are presented in Table (3) .

Table (3) Daily feed intake of rams fed on berseem hay and the potato by – products (on DM bases) .

ITEMS	DM (g / kg^{75})	DM (g / kg)	DMD %	OMD%
Control	114.5	3.95	86.56	69.34
PB-PS	113.21	3.91	58.14	59.24
PB-PH	113.63	3.90	65.04	66.28

Cell wall constituents (C W C) Of the experimental diets :

The means of cell wall constituents of experimental diets are presented in Table (4) . The potato by –products silage (P B- PS) had the lowest contents of neutral detergent fiber (NDF) , acid detergent fiber (ADF) , acid detergent lignin (ADL) , hemicelluloses and cellulose . This agree with Parfitt *et al* , (1982) who found that potato by –products contained 60.6 % cwc , 54.9 % ADF , 5.7 % hemicelluloses , 37.7 % , ADL. and 10.6 % cellulose. These results are more than those obtained here .

Table (4) . Cell wall constituents (CWC) of the experimental diets (on dry matter basis) .

Items	Control	PB-PS	PB-PH
NDF	44.77a±0.19	31.21c±0.40	38.07b±0.35
ADF	32.94a±0.28	24.94c±0.36	29.21b±0.24
ADL	10.26a±0.03	7.10b±0.05	9.34b±0.05
Hemicellulose	9.83a± 0.09	6.27b±0.04	8.86c±0.02
cellulose	24.68a±0.02	17.84b±0.07	19.87a±0.07

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

Rumen liquor parameters :

pH values , ammonia – N levels , and total volatile fatty acids (TVFA) concentration of rumen liquor of the experimental animals are illustrated in Table (5) their significant differences among sampling time ($p< 0.05$) as well as among dietary treatments for all tested parameters . Although NH3 – N concentration gradually decreased by sampling time till the 6 th hours, the pH values decreased only till the 4 th hours , but on the opposite , TVFA´s level gradually increased till 4 th hours . The normal relation of rumen parameters were realized , since there were positive relation between pH value and NH3 –N concentration by negative relations between TVFA´s levels , on one side and either of pH value or NH3- N concentration on the other side . since consuming NH3 –N by Ruminal micro –flora producing TVFA´s leading to lowering pH values . PB-PS produced the lowest pH ($p < 0.05$)compared with other tested groups , whereas NH3 –N concentration and TVFA´s were significantly higher ($p< 0.05$) for same group , this results of overall of pH are in harmony agree with those obtained by Khalifa (1972) who noticed that pH of rumen liquor with sheep was high (7.1) before feeding then declined to (6.8) at 4 hours .

Table (5) . Rumen liquor parameters Rahmany rams fed on potato by – products - silage or hay .

Item	Time	Control	PB-PS	PB-PH
pH	0	6.87±0.11	6.15±0.24	6.92±0.03
	3	6.64a±0.03	6.02b±0.08	6.51a±0.05
	6	6.56a±0.04	6.07b±0.07	6.43a±0.02
Ammonia –N mg / 100 ml	0	14.58b±0.82	22.21a±1.43	16.46b±0.87
	3	16.94b±1.26	25.04a±1.57	1933b±1.06
	6	13.67b±1.12	21.18a.±2.34	14.85a±.0.83
Total VFA meq / 100 ml	0	8.24±0.26	12.56±0.34	7.85±0.49
	3	13.87±0.62	17.67±0.41	13.53±0.71
	6	10.51±0.64	14.24±0.28	9.15±0.37

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

Mollar proportion of ruminal volatile fatty acid (VFA) :

Differences between acetic , propionate , butrtate and Iso – Biotrate values of rumen liquor of rams fed on Potato by- products silage or hay shown in Table (6) . Data clear that there are significant (p< 0.05) decrease in acetic , butrtate and iso – biotrate for PB-PS , compared to control and PB-PH groups , whereas propionate and valerate were significantly higher (p < 0.05) for the same treatments .The A / P ratio indicated an improvement of propionic production in the diet potato by products silage (P B - PS) , the A/P ratio for potato by-products hay group detected the highest value . Results obtained confirming were those represented by El – Ayek (1999) and Mohammed *et al* , (2003) .

Table (6) . Mollar proportion of ruminal volatile fatty acid (VFA) of Rahmany rams fed on potato by –products silage or hay .

Item	Control	PB-PS	PB-PH
Acetate , %	39.86a±1.97	35.55c±1.29	37.33b±0.79
Propionate , %	27.84b±0.87	34.51a±0.27	22.85c±0.70
A : p	1.43:1	1.03:1	1.63:1
Butrtate, %	19.57b±0.71	17.21c±0.62	21.84a±0.58
Iso – biotrate %	2.68a±0.06	1.67b±0.0 2	2.91a±0.03
Valerate, %	1.76b±0.02	2.49a±0.04	1.37b±0.06

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

Total bacterial count of rumen liquor:

Potato by- products silage in Rahmany rams diets has a great effect on the increase of the total viable bacteria count in the rumen (P < 0.05) compared with a control and potato by- products hay groups (Table 6) . Bacterial counts were significantly higher (p< 0.05) for potato by –products silage (PB-PS) before feeding and at 3 hrs of post feeding , the values were 1860 and 2617 x10 7 / ml) . These values were over than the values of other treatments . Whereas the highest significant values recorded for PB-PS at 6 hrs post feeding followed by control and PB-PH groups . The results obtained

from this study are in harmony with those of Kurihara *et al* , (1968) who observed that the peak of bacterial counts was between 4 and 6 hr's after feeding

Total celluolytic bacterial count of rumen liquor :

The results in Table (6) showed that the highest values of total celluolytic bacterial were obtained at 3 hrs after feeding for PB-PS ,but the lowest value was recorder with PB-PH and control group. In this respect , Behraka *et al* , (1991) reported that a large and more active bacterial population in the rumen may help to increase the rate of digestion . These results are in agreement with Nour *et al* (1989) that feeding animals on concentrate with roughages increased the total protozoal count in the rumen .

Total protozoal count of rumen liquor :

After 3 hrs of feeding potato by-products silage showed that the highest total protozoal count was recorded for PB-PS compared to the other treatments , whereas the lowest value was obtained with PB-PH .This may be due to increase level of solanine in potato by-products hay . These results agreed with those obtained by Sony and Sharma (1982) who found an increased in ciliate protozoal count ($p< 0.05$) with increasing concentrate level in diet .This possibly reladed to its to ingest starch . Maximum protozoal counts were observed at 4 hrs post feeding than after feeding.

Table (7) . Effect of potato by-products silage or hay feeding on rumen microorganisms

Items	Time	Control	PB-PS	PB-PH
Total bacterial count (107/ ml)	0	1519b±43	1860a±44	1347c±67
	3	2175b±57	2617a±64	2080c±37
	6	3818b±39	4346a±51	3576c±26
Cellullolytic bacterial(104 / ml)	0	2.91b±0.05	3.16a±0.08	2.46b±0.12
	3	4.68a±0.03	5.57a±0.06	3.91b±0.02
	6	3.72b±0.07	4.65a±0.03	2.64c±0.07
Total protozoal count(104 / /ml	0	3.97b±0.08	4.61a±0.02	3.88b±0.05
	3	3.41b±0.03	4.79a±0.04	3.52b±0.07
	6	2.97b±0.05	4.27a±0.06	3.11b±0.01

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

Hematological picture :

The hematological picture of Rahmany rams fed on potato by –products silage or hay Table (8), showed significant ($p< 0.05$) decrease in erythrocyte and leucocytes for PB-PH compared with PB-PS and control groups Table(8) . On the other hand the two fraction of white blood cells (neutrophile and lymphocyte %) and eiosinophile were significantly increased ($p < 0.05$) with PBPH group, whereas the monocyte significantly decrease to same group .This increases of lymphocyte and neutrophile for PB-PH group may be due to the increases of solanine level and the decreases of protein compared with PB-PS and control groups Addition to that, solanine have an

enhancement effect to the humoral immune response and increase white blood cells as reported by Pollman *et al* , (1980) .and Saleh *et al* . (2007).

Table (8) . Blood picture of Rahmany rams fed on potato by - products silage or hay

Items	Control	PB-PS	PB-PH
WBCs (10^3 ul)	6.08b ±0.17	6.19b±0.08	7.43a ±0.11
Lymphocyte (%)	55.8b ±2.6	57.3b±3.8	63.7a±2.3
Neutrophile (%)	42.5b±2.13	41.8b± 1.6	57.9a ±1.8
RBCs (10^6 ul)	10.04a ± 0.18	10.77a ±0.12	8.58b ± 0.06
Eiosinophile (%)	5.2b±0.3	4.7b ±0.3	6.9a±0.1
Monocyte (%)	17.5b ±0.8	21.9a± 1.4	14.7c±0.6

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

CONCLUSION

This study indicated that potato by-products silage could be used successfully for feeding ruminants and could be replace with berseem hay in sheep diets .

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مخلفات البطاطس كغذاء حيواني .3 – السولانين فى مخلفات البطاطس واثره على نشاط الكائنات الحيه وبعض مقاييس الكرش .

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تم إستخدام 9 كباش رحماني متوسط أوزانهم 70 كجم عند عمر 3 سنوات بمحطة التجارب والبحوث بالسرو لدراسة تأثير سيلاج ودريس مخلفات البطاطس على نشاط الكائنات الحيه بالكرش . قسمت الكباش عشوائيا إلى ثلاثة مجاميع , المجموعة الأولى وغذيت على50 % علف مركز +50 % دريس برسيم , المجموعة الثانية غذيت سيلاج مخلفات البطاطس (عروش ودرنات). المجموعة الثالثة غذيت على دريس مخلفات البطاطس (عروش ودرنات) كبديل لدريس البرسيم . وتم إجراء تقدير القيمة الهضمية وقياسات الدم وتقدير صفات سائل الكرش , وأظهرت نتائج التحليل الكيماوى أن سيلاج مخلفات البطاطس كان منخفض معنويا بمستوى 0.05 فى محتواه من الالياف الخام ومرتفع فى البروتين والمستخلص الإثيرى والمستخلص الخالى الآزوت مقارنة بمعاملة دريس مخلفات البطاطس والمقارنه ، بينما إرتفع معنويا دريس مخلفات البطاطس فى محتواه من الالياف و السولانين و انخفض محتوى سيلاج مخلفات البطاطس من NDF , ADF , ADL , Cellulose , Hemicelluloses إنخفاضا معنويا على مستوى 0.05 بينما إرتفعت كل هذه القيم مع دريس مخلفات البطاطس ودريس البرسيم . كما اوضحت النتائج أن دريس مخلفات البطاطس كان مرتفعا معنويا بمستوى 0.05 فى الاسيتات , والبيوترات والايزو بيوترات بينما سجل السيلاج أعلى قيمه فى محتواها من البربيونيك وأقل قيمه للنسبه بين الآستيك والبيوتريك و الفاليرات مقارنة بمعاملة دريس البرسيم , كما إرتفعت الآمونيا والأحماض الكليه الطياره إرتفاعا معنويا فى مجموعة السيلاج متبوعه بمعاملة الدريس ثم مجموعة المقارنه خلال المراحل المختلفه . أما العد الكلى للبكتريا والبكتريا المحلله للسيللوز و العد الكلى للبروتوزوا كانت مرتفعه معنويا فى سيلاج مخلفات البطاطس خلال المراحل الزمنيه الثلاثه للتحليل مقارنة بمجموعة الدريس ومجموعة المقارنه , ومن ناحية أخرى وجد أن مجموعة دريس مخلفات البطاطس كانت أقل المجاميع المختبره فى محتواها من كرات الدم الحمراءRBCs , Monocyte , بينما إرتفع محتواها من كرات الدم البيضاء WBCs , Neutrophile , Eiosinophile , Lymphocyte بينما انخفضت هذه القيم مع مجاميع الدريس و المقارنه .