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POTATO BY-PRODUCTS AS ANIMAL FEED. 1-PHYSICAL PROPERTIES AND SEMEN CHARACTERISTICS OF RAHMANY RAMS AS AFFECTED BY POTATO BY-PRODUCTS SOLANINE.

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ABSTRACT

Nine Rahmany rams with an average body weight of 70.35 ± 1.7 kg and 3 years of age were used at El-Serw Experimental Research Station to study the effect of silage and hay of potato by-product (vine and greenish spots small and damage tubers) on feeding values and semen characteristics. Rams were randomly divided into three treatment groups, assigned to three trials with three experimental rations. The first trial was to evaluate digestibility and nutritive values; the second trial to estimate blood parameters and the third trial was carried out to evaluate semen characteristics. The experimental diets were given according to NRC (1990), first group fed 50% concentrate feed mixture (CFM) + 50% berseem hay as a control (CBH), second group fed 50% CFM + 50% potato by-products + 5% molasses + 3% urea as silage (PB-PS) and third group fed 50% CFM + 50% potato by- products hay (PB-PH). The experiment lasted for 12 weeks .The obtained results showed that digestibility of crude protein and ether extract of PB-PH decreased than of PB-PS and CBH groups. Also, DCP significantly decreased in PB-PH ($P < 0.05$) in comparison to the other treatments. Results explained that blood parameters for group fed PB-PH were significantly ($P < 0.05$) decreased (RBC, total protein, albumin, globulin and cholesterol). However, hematocrit, AST, ALT, urea, creatinine and bilirubin values of PB-PH group were significantly ($P < 0.05$) increased compared to PB-PS and CBH groups. Ration containing CBH and PB-PS recorded higher ($P < 0.05$) semen characteristics than PB-PH ration. Ejaculate volume was 1.65 ± 0.07, 1.63 ± 0.13 and 1.48 ± 0.17 ml for ram groups fed CBH, PB-PS and PB-PH, respectively .The percentage of sperm motility was lower for PB-PH group (80.5 ± 3.86) than both CBH (87.39 ± 1.37) and PB-PS (86.11 ± 1.43). Rations containing CBH and PB-PS led to a significant ($P < 0.05$) increase in live spermatozoa compared with PB-PH ration. Feeding CBH and PB-PS rations accompanied with higher sperm cell concentration than for those fed PB-PH ration. The sperm cell concentration was 3.73 ± 0.14, 3.66 ± 0.15 and 2.86 ± 0.90 x 10^9/ml for rams were fed CBH, PB-PS and PB-PH, respectively. The feed cost was decrease with PB-PS and PB-PH compared with the control one.

Therefore, the present study found that potato by-products silage could improve nutrition and semen characteristics in rams and reduce feed cost.

Keywords: Rahmany rams – Potato by-products – Silage – Hay.

INTRODUCTION

The quantities of local feedstuffs are insufficient to cover the nutritional feed requirements of animals during recent years in Egypt. The wastes are one of the most effective ways to improve animal feed resources. The potato wastes (green parts) could be used as rations for animal feeding to reduce feed cost and restricting of concentrate mixture. Solanine

($C_{45}H_{73}NO_{15}$) is a glycoalkaloid poison found in species of the *Solanaceae* family. It can occur naturally in any part of the plant, including the leaves, fruit, and tubers. It is very toxic even in small quantities. Solanine has both fungicidal and pesticidal effects. It is made of the alkaloid solanidine and carbohydrate (glyco-) side-chains (Fig. 1, Karl and Harrison, 2001).

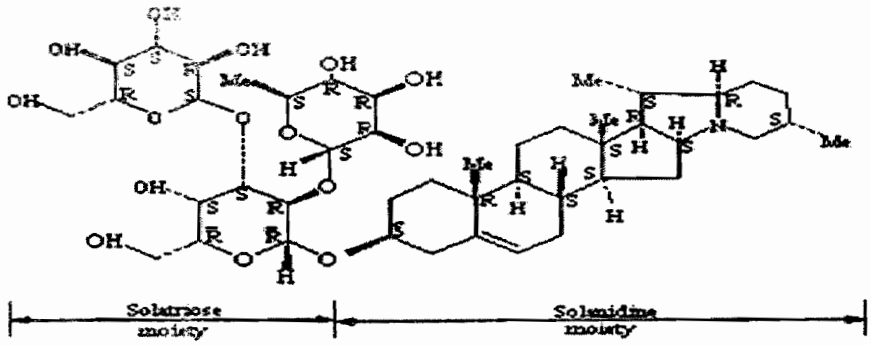

Fig. 1: *Solanine structure*

Exposure to light is only one of the stress factors affecting potatoes. Glycoalkaloids (α solanine and α chaconine) are naturally occurring toxins found in all parts. of potato. They comprise approximately 95% of total potatoes glycoalkaloids (Olsen, 1989). The toxic does is considered to be approximately 2 – 5 mg/kg live body weight. Also, approximately more than 2000 cases of poisoning and numerous livestock losses have been reported as caused by consumption of potatoes with high concentration of solanine (Morris and Lee, 1984). Poisoning in a few cases caused deaths that have occurred when potatoes with high solanine were consumed (Willimott, 1988). 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, blood parameters and semen physical characteristics comparable with concentrate feed mixture (CFM) + berseem hay (CBH).

MATERIALS AND METHODS

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

Experimental animals:

Nine sexual mature Rahmany rams were used in this study having average live body weight of 70.35 ± 1.7kg and about 3 years of age. All rams were healthy and free of diseases. Both testes were almost equal in size and moved freely with the scrotal pouches. The rams were divided randomly into three similar groups (three rams in each) according to body weight and age. Rams were housed in groups and kept under shade.

Feeding and management:

The control ration (CBH) contained 50% concentration feed mixture + 50% berseem hay, second group fed on 50 % CFM + 50 % potatoes by-products + 5% molasses + 3% urea as silage (PB-PS) and third group fed on 50 % CFM + 50% potatoes by- products as hay (PB-PH). Feed was offered two times/day at 8 am and 3 pm. Feed intake and feces weight were recorded daily. Mineral blocks were available freely thought the experimental period. Chemical analysis of ingredients and diets are presented in Table (1).

Table 1: Chemical analysis of ingredients and experimental rations fed by Rahmany rams (%on dry matter basis).

Item, %	DM	OM	CP	CF	EE	ASH	NFE
Analysis of ingredients:							
CFM	90.13	89.70	14.88	13.40	3.10	10.30	58.32
BH	88.56	88.58	14.16	25.14	2.59	11.42	46.69
PB-PS	86.79	86.23	13.08	14.20	3.48	13.77	55.47
PB-PH	89.41	88.49	11.89	17.55	2.76	11.51	56.29
Analysis of rations:							
Control	88.58	89.22a	13.94a	14.09 b	2.85b	10.78a	58.34a
PB-PS	87.34	90.24a	12.30a	11.48 c	3.46a	9.76b	61.10a
PB-PH	89.72	89.57a	11.59a	17.55 a	2.76b	10.43a	57.82b

a and b Means having different superscripts within the same column are significantly different aCFM = Concentrate feed mixture, BH = berseem hay PB-PS = Potato by-products silage, PB-PH = Potato by-products hay.

Chemical analysis:

Feces were collected daily in plastic bags from each ram and composite samples were prepared for chemical analysis. Feces samples were analyzed 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 Carman *et al.* (1984) and Bushway and Bureau (1985).

To analyse blood, samples were taken from all rams of each group from the jugular vein twice a week before morning feeding. Blood sample were divided into two parts one to estimate red blood cells, white blood cells, hemoglobin and hematocrit and the other part was centrifuged for 20 min. at 3000 rpm and then plasma separated and stored at –20°C till analysis. The plasma samples were used for the determinations. Transaminase activity (AST& ALT) were determined after (Reitman and Frankel, 1957), total protein (Weichselbaum, 1989), albumin (Doumas *et al.*, 1971) globulin (calculated by difference), urea (Patton and Crouch 1977), creatinine (Bartiles, 1971), total cholesterol (Schettler and Nüssel, 1975) and bilirubin (Monnet, 1963) using commercial kits.

Semen evaluation:

To evaluate semen characteristics, semen was collected after 54 days from start of the feeding. The spermatogenesis takes this period. (Evans and Maxwell, 1987a). Semen was collected twice a week from each ram for six consequetive weeks using the artificial vagina method. Semen

ejaculates were collected before feeding. Each ejaculate was taken immediately to the laboratory and kept in water bath at 37°C. Each ejaculate was estimated for ejaculate volume (ml), consistency (0 - 5), pH (using pH meter), mass motility, progressive motility (%), live sperm (%), abnormality (%), sperm cell concentration ($x10^9$/ml, using hemocytometer) and sperm cell out put/ ejaculate (semen volume x sperm cell concentration) according to (Evans and Maxwell. (1987b). Moreover, reaction time was estimated using stop watch. The physical properties of semen were detected and stimulated according to Khalifa (1997). The R.T. was the period elapsed from the ewe is available to ram and the minute of semen ejaculation.

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

Feeding values:

The results presented in Table 2 explained solanine levels in PB-PS, PB-PH and feces. Solanine level in potato by –products hay was high in both diet and feces and significantly ($P < 0.05$) increased than in potatoes silage .The total daily intake of each animal was 133.88 and 382.51 mg for both PB-PS and PB-PH, respectively. On the other hand, the feces took 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 or to ammonia supplementation. The results agreed with Alozie *et al.* (1979). Normal levels of solanine in various tuber tissue in mg/100g FW are: whole tuber 7.5 (4.3 - 9.7), flesh 1.2 - 5, skin 2-3% (30 - 60) of tuber, peel 10-15% of tuber (15 - 30), bitter tuber 25 – 80, peel from bitter tube 150 – 220 (Wood and Young, 1974).

Table 2: Solanine determined in PB-PS, PB-PH rations consumed and feces of Rahmany rams.

Items	Solanine consumed, mg/100g		Solanine consumed, mg/h/d	
	PB-PS	PB-PH	PB-PS	PB-PH
Diets	7.19 ± 0.07b	19.86 ± 1.12a	133.88 ± 2.37b	382.51 ± 5.15a
Feces	2.64 ± 0.03b	6.11 ± 0.09a	40.33 ± 0.94b	121.38 ± 3.76a

a and b Means having different superscripts within the same row are significantly different at ($P < 0.05$).

Digestibility coefficients on dry matter (DM) bases and nutritive value of the experimental rations are shown in Table 3. Digestion coefficients for both crude protein (CP) and ether extract (EE) were significantly lower by feeding PB-PH. This is in agreement with Parfitt *et* al. (1982) and Azim *et al.* (1984) who reported that solanine affectes the digestible protein. Also, TDN was significantly decreased ($P<0.05$) in PB-PH in comparison to other treatments.

Table 3: Digestibility coefficient and nutritive value of the experimental rations (on DM bases)

Parameters	Experimental rations		
	Control	PB-PS	PB-PH
Digestibility coefficient % DM	68.56 ± 0.09a	58.14 ± 0.14b	65.04 ± 0.02a
OM	69.34 ± 1.13a	59.24 ± 0.07b	66.28 ± 1.04a
CF	58.64 ± 0.60b	44.21 ± 0.50c	63.19 ± 1.21a
CP	66.86 ± 1.09a	68.44 ± 0.30a	61.83 ± 1.13b
EE	62.88 ± 0.57b	66.78 ± 0.37a	60.30 ± 0.90b
NFE	66.94 ± 0.66a	63.48 ± 0.52b	68.60 ± 1.37a
Nutritive value % TDN	62.78 ± 0.69a	59.43 ± 0.04b	63.21 ± 0.60a
DCP	11.25 ± 0.40a	11.20 ± 0.06a	10.53 ± 0.26b

a, b and c: Means with different superscripts within the same row are significantly different at (P < 0.05).

Blood parameters:

The blood parameters data are in Table 4. Data indicate that group fed on PB-PH had significantly (P < 0.05) decreased RBC, hemoglobin, total protein, albumin, globulin and cholesterol, but significantly (P < 0.05) increased hematocrit, liver enzymes (AST, ALT), urea , creatinine and bilirubin compared with PB-PS and the control groups . At the same time, there were no variations between PB-PS and control groups, in accordance with Dalvi (1985). Comparative assessment of the effect of solanine administered on hepatic dysfunction in male rats was done by Harvey *et al.* (1986).

Table 4: Effect of experimental treatments on some blood parameters of Rahmany rams.

Items	Experimental treatments		
	Control	PB-PS	PB-PH
R .B.C ($X10^5$/µl)	10.04 ± 0.18a	10.77 ± 0.12a	8.58 ± 0.06b
W.B.C ($X10^3$/µl)	7.45 ± 0.17a	7.19 ± 0.08a	6.43 ± 0.11a
Hemoglobin (g/dl)	9.56 ± 0.18a	9.79 ± 0.008a	8.22 ± 0.16b
Hematocrit (%)	23.87 ± 0.10b	21.3 ± 1.40 b	35.7 ± 0.28a
Total protein (g/100 ml)	8.81 ± 1.16a	8.67 ± 1.31a	7.02 ± 1.16b
Albumin (g/100 ml)	4.26 ± 1.23a	4.37 ± 1.02a	3.49 ± 1.22b
Globulin (g/100 ml)	4.55 ± 0.86a	4.30 ± 1.23a	3.53 ± 1.16b
AST (µ/ml)	36.00 ± 2.58b	41.00 ± 1.86b	64.00 ± 3.12a
ALT (µ/ml)	31.00 ± 3.02b	28.00 ± 2.37b	37.00 ± 1.46a
T. cholesterol(mg/100ml)	84.00 ± 3.23a	75.00 ± 2.89a	56.79 ± 4.61b
Urea (mg/100ml)	21.40 ± 2.05b	19.88 ± 0.61b	28.11 ± 1.58a
Creatinine (mg/100 ml)	0.73 ± 0.40b	0.58 ± 0.56b	1.36 ± 0.28a
Bilirubin mg/100 ml)	0.34 ± 0.04c	0.48 ± 0.06b	0.72 ± 0.02a

a, b and c Means having different superscripts within the same row are significantly different at (P < 0.05).

Semen quality:

Reaction time with PB-PH ration significantly (P < 0.05) decreased than CBH and PB-PS rations (Table 5). Reaction time (libido) of male mammals is under the control of androgens (Bone, 1979 and Hammoned *et*

al., 1983). The cholesterol is transported to mitochondria resulting in pregnenolone converted to progesterone which leads to androgen (Hafez, 1987). Rams fed CBH and PB-PS ration had high cholesterol level that let to activate the androgen which promote the interstitial cell (leydig cells), stimulating the secretion of testosterone hormone which is responsible for acquiring the highest libido (Mokhless and Ibrahim, 1990).

Table 5: Semen physical characteristics for Rahmany rams fed the experimental rations.

Semen characteristics	Experimental rations		
	Control	PB-PS	PB-PH
Relation time (min)	1.12 ± 0.14b	1.21 ± 0.11b	1.84 ± 0.33a
Semen volume (ml)	1.65 ± 0.07a	1.63 ± 0.13a	1.48 ± 0.17b
Consistency (0 -5)	4.12 ± 0.08a	4.11 ±.0.10a	3.31 ± 0.48b
PH	6.46 ± 0.05b	6.42 ± 0.03b	6.79 ± 0.08a
Mass motility (0- 5)	4.35 ± 0.15a	4.28 ± 0.16a	3.24 ± 0.22 b
Progressive motility (%)	87.39 ± 1.37a	86.11± 1.43a	80.50 ± 3.86
Live spermatozoa (%)	11.50 ± 1.31b	13.72 ±1.43b	18.94 ± 3.77a
Abnormalities (%)	13.65 ± 0.83b	14.69 ± 0.79	20.54 ± 1.39a
Sperm cells concentration (X 10^9/ml)	3.73 ± 0.14a	3.66 ± 0.15a	2.86 ± 0.90
Sperm cell per ejaculate (X 10^9/ml)	6.16 ± 0.29a	5.98 ± 0.40a	4.22 ± 0.38b

a and b Means having different superscripts within the same row are significantly different at (P < 0.05).

Ejaculate volume was higher significantly (P < 0.05) for rams fed ration contained CBH and PB-PS compared with those fed PB-PH ration. Rams fed CBH produced the greatest semen volume followed by PB-PS then those fed PB-PH. The highest ejaculate volume may be due to high level of cholesterol that is important to produce androgen which stimulates the accessory glands let to release great size form seminal plasma. Also, the addition of urea to PB-PS rations which convertible to protein that is important to synthesis seminal plasma (Abdel-Rahman *et al.*, 2000).

Sperm motility (mass and progressive) increased significantly (P<0.05) when rams fed either CBH or PB-PS compared with those fed PB-PH. The improvement in sperm cell motility when rams fed CBH and PB-PS may be due to CBH and PB-PS which had higher concentration of calcium than PB-PH that increase the influx of Ca^{++} into the sperm cell leading to the increase of metabolic activity of sperm and consequently increase in sperm motility. This agrees with the explanation by Morton *et al.* (1974). Moreover, Farag *et al.* (1983), Zeidan(1995) and Hafez and Hafez (2000) found that calcium has been involved in the activation of many enzymes necessary for maturation, metabolism, motility and membrane properties of spermatozoa.
Consistency and PH were higher significantly (P < 0.05) in CBH and PB-PS rations than PB-PH ration (Table 5). The semen consistency and pH depended on the ratio of constituents, the spermatozoa concentration and the seminal plasma. Semen samples of thick consistency contain more spermatozoa than those of thin consistency (Evanse and Maxwell, 1987b).
The higher live sperm was reported with rams fed CBH and PB-PS, that may be due to higher total protein concentration of blood in CBH (8.81± 1.16

g/100 ml) and PB-PS (8.67±1.31 g / 100 ml) that accompanied with an increase in live sperm than PB-PH (7.02±1.16 g/100 ml) rations. Protein plays an important role for sperm cells membrane that leading to increase foundation and protection (Hafez, 1987).

There were significant variations ($P < 0.05$) in the percentage of abnormal spermatozoa among CBH, PB-PS and PB-PH rations. The PB-PH ration was accompanied with higher percentage of abnormal sperm cells (20.54%) compared with (13.65%) and (14.69%) for CBH and PB-PS, respectively. The highest sperm abnormities for PB -PH may be due to low protein level that is essential for sperm cells structure. Also, low cholesterol concentration with PB-PH ration let to decrease sexual hormones effecting on sperm cell structure in testes and epididymis.

The results showed that rams fed CBH and PB-PS had higher significant sperm concentration ($P < 0.05$) compared with those fed PB-PH. The highest sperm cell concentration for CBH and PB-PS may be due to the increase of cholesterol that converted to testosterone hormone which controls spermatogenesis and increases production in sperm cells (Bone, 1979 and Hammoned *et al.*, 1983).

The sperm cells out put for CBH and PB-PS were higher significantly ($P < 0.05$) than PB-PH ration. Sperm cell out put increased in CBH and PB-PS rations may be attributed to the higher protein content (Table 1).

CONCLUSION

This study indicated that potato by-products silage could be used successfully for feeding rumminants and improve semen characteristics of rams.

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مخلفات البطاطس كغـذاء حيوانى.

١- الصفات الطبيعية وخصائص السائل المنوى فى الكباش الرحمانى التى تـأثرت بالسولانين في مخلفات البطاطس.

مصطفى راشد محمـد صالح ، عبد المرضـى عبد العزيز ، عـزالدين خليفـة و جمال إبراهيم الإمام

معهد بحوث الإنتاج الحيوانى - مركز البحوث الزراعية - دقى - مصر

تم استخدام ٩ كباش رحمانى متوسط أوزانهم ٧٠ كجم عند عمر ٣ سـنوات بمحطـة التجـارب والبحوث بالسرو لدراسة تأثير سيلاج ودريس مخلفات البطاطس على التقييم الغذائي وصفات السائل المنـوى للكباش الرحمانى. قسمت الكباش عشوائيا إلى ثلاثة مجاميع، المجموعة الأولى كنترول وغذيت على العلف المركز + ٥٠ % دريس برسيم، المجموعة الثانية غذيت سيلاج مخلفات البطاطس (عـروش ودرنـات) + ٥% مولاس + ٣% يوريا، المجموعة الثالثة غذيت على دريس مخلفات البطاطس (عروش ودرنات). وتم إجراء تقدير القيمة الهضمية وقياسات الدم وتقدير صفات السائل المنوى بعد ١٢ أسبوع تغذيـة، وأظهـرت النتائج أن معاملات الهضم للبروتين والدهن كانت منخفضة معنويا عند مـستوى ٥% مـع عليقـه دريـس مخلفات البطاطس، وسجلت علائق سيلاج مخلفات البطاطس والعليقة المركزة أعلى النتائج لمعاملات هـضم البروتين والدهن والقيمة الغذائية كبروتين مهضوم. كما أوضحت النتائج أن صفات الـدم انخفـضت مـع الكباش التى تغذت على عليقه دريس مخلفات البطاطس عند مستوى معنوية ٥% بالمقارنة بعليقـة مخلفـات البطاطس المسيلجة والعليقة المركزة. سجلت الكباش المغذاة علـى العليقـة المركـزة وسـيلاج مخلفـات البطاطس ارتفاع معنوي عند مستوى ٥% في صفات السائل المنوى بالمقارنة بالتغذية على دريس مخلفـات البطاطس. فكان حجم القذفة ١,٦٥, ١,٦٣ و١,٤٨ مل, ونسبة الحركة التقدمية للحيـوان المنـوى ٨٧,٣٩ , ٨٦,١١ , ٨٠,٥٠, وتركيز الحيوانات المنوية ($١٠^{٩}$x) ٣,٧٣ , ٣,٦٦, ٢,٨٦ لكل من العلائـق المختبـرة (الكنترول, سيلاج عروش البطاطس, دريس عروش البطاطس على التوالى).

من هذه الدراسة نستخلص أن استخدام سيلاج مخلفات البطاطس أدى إلى تحسين الـصفات التناسـلية والغذائية عن دريس مخلفات البطاطس على الكباش الرحمانى.