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NUTRITIVE VALUE OF SOME AGRICULTURAL BY-PRODUCTS IN FEEDING RABBITS

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ABSTRACT: A total number of forty eight New Zealand white (NZW) male rabbits (5 weeks of age) were used in two experiments. The 1st experiment was to evaluate the chemical composition and feeding value of sugar beet pulp (SBP) as feedstuff for rabbits feeding, while the 2nd experiment was to find out the effect of different levels of sugar beet pulp on the performance and feed efficiency as well as digestibility coefficients of nutrients and some carcass traits.

Obtained results showed that SBP contained CP (9.0%), CF (20.00%), EE (1.00%) and ash (4.90%). the digestion coefficient values of SBP were 59.19, 54.09, 76.77 and 81.94% for CP, CF, EE and NFE while the percentage of nutrient values were found to be 6.77 DCP, 73.78 TDN and 3227 DE Kcal/Kg, respectively.

At the end of the experiment (12 weeks of age), the average live weight of rabbits were 1910 , 2001, 2050 and 2109 g for rabbits fed on diet with 0,5,10 and 15% SBP diet, respectively . Level of 15% SBP in the diet resulted in the highest ($P < 0.05$) LBW. Rabbits fed on 15% BSP diet recorded in the best average weight gain than any other treatment group up to 12 weeks of age. Feed intake of rabbits insignificantly ($P < 0.05$) increased as SBP increased in the diet from 5-12 week of age. During the whole experimental period from 5-12 weeks of age rabbits fed on 15% SBP in the diet showed the best value ($P < 0.05$) of feed converison (3.88), while rabbits fed on 10% SBP in the diet showed the higher value of PER(1.68) followed by those fed on 15 and 5% SBP in the diet. However , the lower PER (1.33)was recorded by rabbits fed on free of SBP(0.0 %) in the diet. Diets contain 10% or 5% and / or 15% SBP levels significantly

(P < 0.01) improved EEU (6.13 and 6.25 Kcal/kg gain) compared with control (7.58 Kcal/kg gain). The dressing percentage of warm carcass (WC) were (65.17, 66.60, 63.16 and 64.60%) for rabbits fed on diets with 0,5,10 and 15% SBP respectively. The economic efficiency values at the and of the experimental period ranged from 173.58 (0.0% SBP) diet to 228.57 (15% SBP) diet.

In meantime, diet contained 15 % SBP had better net return, economic efficiency and performance index. From this study it can be recommended to incorporate sugar beet pulp in feeding of growing rabbits at 15% without adversal effect on their growth.

Key words: Rabbits, sugar beet pulp, digestibility, performance carcass trait.

INTRODUCTION

Some by-products originated from food industry processing are utilized in animal feeding to minimize feed cost in animal production. One of these by-products is the sugar beet pulp. In Egypt, sugar industry from sugar beet (Beta vulgaris L.) has been recently introduced. Sugar beet pulp (SBP), the by-product of sugar beet, was noted to be a valuable feed for most farm livestock (UK, Ministry of Agriculture, Fisheries and food, ADAS, 1982). El-Delta company of sugar in Egypt (personal communication cited by Darwish et al. 1989) indicated that the average yeild of fresh sugar beet roots is 25 tons/ feddan. This lot produces 3.75 tons of sugar and 1.5 tons of sugar beet pulp (SBP) containing 10-12% moistuer. In term of DE Yeild, about 5280 Mcal of DE could be produced/feddan (El-Adawy et al. 2000). Bhattacharga and Sleiman (1970). reported that SBP energy was utilized as well as corn or barley up to 60% in concentrate rations for ruminants. Moreover, Kelly et al.(1990) pointed out to its high crude fiber (CF) digestibility. Its high CF content can depress the digestive disorder which could happen with the concentrate rations. Arora et al. (1975) suggested that the beet pulp could not be regarded as a concentrate. Bhattacharga and Lubbadah (1971) cited that SBP efficiency of utilization depend upon proper supplementation of its nutrient deficiencies.

Therefore, the principle of this study is to evaluate SBP as feedstuff and the effect of

replacing SBP levels in the diet on growth performance, digestibility coefficients, carcass traits, as well as the economical efficiency of growing rabbits.

MATERIALS AND METHODS

This work was planned at the Department of Animal production, Faculty of Agriculture, Zagazig University, while the experimental work was conducted in Noubaria Experiments unit, By-product Department, Animal production Research Institute, Agricultural Research Center, Ministry of Agriculture. The analytical work was performed at the laboratories of the same unit. The experimental work was lasted for 12 weeks from 15 September to 9 December 2002.

Experimental Design:

The first experiment was designed to evaluate the chemical composition and feeding value of SBP as feedstuff for rabbits feeding, while in the second experiment four experimental groups of rabbits were fed on 4 experimental diets of different levels of SBP as an agricultural by-products for substitution of yellow corn in rabbit diets as follows: the 1st group was fed on basal diet (without SBP), while the 2nd , 3nd , and 4th groups were fed on diets contained 5, 10 and 15 % SBP, respectively (Table. 1).

A . Animals:

A total number of 48 male New Zealand White rabbits of 5 weeks old were used and treated up to 12 weeks in this study. Rabbits were divided into 4 groups. All groups were equal in numbers (12 rabbits each) and was divided into 4 subgroups (replicates), 3 rabbits each.

All rabbits were approximately similar in the initial body weight at the beginning of the experiment.

B- Rations:

All the experimental diets were nearly isocaloric (2650.98 to 2682.48 Kcal/kg) and also nearly isonutreginous (16.14 to 16.60%) and crude fiber (12.20 to 12.60%). All diets were in pelleted form.

The composition and chemical analysis of the experimental diets are presented in Table1. Commercial sugar beet pulp (SBP) was used in formulating the experimental diet . It contained 90.00% DM ,85.10 % OM, 9.00% CP , 20.00% CF ,1.00 % EE 55.10% NFE , 4.90 %ASH ,0.74%

Calcium ,0.60% Phosphorus and 2818 Kcal/DE/Kg.

C. Management:

Rabbits were housed in galvanized wire cage batteries and kept under similar hygienic condition. Diets were offered to rabbits ad-libitum and fresh water was automatically available all the time by stainless steel nipples. Live body weight and feed consumption were recorded weekly interval during the experimental periods, while body weight gain, feed conversion, protein efficiency ratio and efficiency of energy utilization were calculated according to North (1980). At the termination of the feeding periods, digestibility trials were carried out using 12 male rabbits (3 for each replicate) according to the method described by Radwan et al., (1971).

Digestibility and nitrogen balance trials :

A total number of twelve NZW male rabbits were distributed at random into four experimental groups (3 rabbits for each treatment). Rabbits were individually kept in metabolic cages that allow to collect feces and urine separately. Samples of daily feces (20%) of each rabbit were collected every day and kept for chemical analysis. Urine was quantitatively collected for each animal, the volume was measured and freezing stored for analysis.

The total digestible nutrients (TDN) were calculated according to the classic formula of Cheeke et al. (1982), while the digestible energy (DE kcal /kg) was calculated according to Schieman et al. (1972) as follows:

DE (Kcal/kg) = $5.28\ X_1 + 9.51\ X_2 + 4.2\ (X_3+X_4)$ where :

X_1 = digestible CP g/kg.

X_2 = digestible EE g/kg.

X_3 = digestible CF g/kg.

X_4 = digestible NFE g/kg.

Slaughter triats :

At the end of the experiment, four representative male rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughter according to Blasco et al. (1992) for determination of carcass traits.

The proximate analysis was carried out on representative samples using the conventional methods of A.O.A.C., (1980).

The economical efficacy was calculated according to the following equation :

EE= (A-B) / B X 100

Where, A is the selling price (L.E) of obtained gain and B is the feeding cost of this gain in Egyptian pounds.

Statistical Analysis :

Data were analyzed by using SAS software (SAS Institute, 1986). Duncan new multiple range test was used for the detection the signification between means (Duncas 1955)

RESULTS AND DISCUSSION

1. Evaluation of sugar beet pulp as a waste product for feeding rabbits:

Results in Table 2 indicated that sugar beet pulp (SBP) contained considerable amout of DE (3227 Kcal/kg), CF (20%) and CP (9%).

However El-Adawy et al. (2000) in his study demonstrated that SBP contained DM (92.64%), OM 85.01%), CP (9.14%), EE (1.04%), CF (21.85%) and DE Kcal/kg (2727.72) according to Fekete and Gippert (1986).

Results indicated that digestibility coefficients of nutrients in SBP were 58.19, 54.09, 54.09, 76.77 and 81.44% for CP, CF, EE and NFE, respectively. The percentage of nutritive values of tested SBP were found to be 6.77 DCP, 73.78 TDN and 3227 DE Kcal/kg (Table 2).

2. Effect of inclusion sugar beet pulp at different levels in the diet on digestibility coefficients and nutritive values:

From Table. 2, it is noticed that the digestibility coefficients values for DM, OM and EE showed significant differences ($P<0.05$) due to the presence of SBP in the diet . However, incorporation of SBP up to 15% in the diet of rabbits had showed better digestibility coefficients of nutrients, where it recorded higher values of CP, CF and EE. being 67.10, 43.60 and 80.36, respectively, although it were insignificant with the other experimental diets.

Skrivanova et al. (1996) reported that using sugar beet pulp in diet of rabbits at 0 or 20% levels had lowered digestibility of hemicellulose and pectin. It was significantly lower ($P < 0.05$) in rabbits fed on 32.80 and 38.40% VS 71.10 and 82.30%. El Zeiny et al. (1998) illustrated that using 0,

5, 10, 15, 20 and 25% SBP in rabbit diets did not affected digestibility coefficients of DM, OM, CP, CF, NFE and N.V (percent total digestible nutrients and digestible CP). Digestibility of EE increased ($P < 0.05$) with 5% SBP in diet.

3. Growth performance:

From Table. 4, it is noticed that accumulated results at the end of experiment (12 weeks of age) showed that the live body weight were 1910, 1995, 2050 and 2109 g for rabbits fed on diets contained 0, 5, 10 and 15% SBP, respectively. However levels of 10 and 15% SBP in the diet recorded the heaviest ($P < 0.01$) body weight (2055 g), while 0%SBP in the diet recorded the lowest body weight (1911) g.

During the whole experimental period (5-12 weeks of age), the inclusion of 10 and 15% SBP in the diets showed the significant ($P < 0.05$) higher daily gain (25.19 and 25.79 g). However level of 0% resulted in the lowest ($P < 0.05$) weight gain (21.67 g). Skrivanova et al. (1996) reported that average daily live weight gain at 87 days old was 30.20, 28.90, 31.52 and 30.5gm as a result of feeding diets contained 7, 15, 5 and 0% SBP level. El-Adawy et al. (2000) revealed that the effect of replacing lucerne hay with 50 or 100% sugar beet pulp significantly decreased ($P < 0.01$) daily weight gain.

Concerning feed conversion , results in Table 3 indicated that the level of 15% SBP in diet resulted in the best value of FC (3.76) followed by those diets contained 10, 5 and 0% SBP diet (3.82, 4.04 and 4.36), respectively. Jensen (1992) resulted that in which pulpetter (dried sugar beet pulp) was used at 10, 20 and 30%. In compound feed mixtures, feed conversion was 3.50, 3.69 and 4.05 in experiment in which pulpetter and hostter (dried sugar beet pulp containing 35% molasses) were used in feeding rabbits, feed conversion were the highest at 10% for pulpetter and 15-20% for kosetter.

The efficiency of energy utilization (EEU) showed significant differences among treatment groups. Diets contains 10% SBP resulated in the best value (6.13) followed by 5 and 15% levels (6.18 and 6.25), respectively. However level of 0% SBP in the diet recorded the worst value of EEU (7.58).

There were significant differences ($P < 0.01$) among treatment groups in the PER value at the end of the whole experimental period. Rabbits fed on 10% SBP in the diet showed the highest value (1.68) followed by these fed on 15 and 10% SBP diets (1.54 and 1.51, respectively), while rabbits fed on 0% SBP diet was recorded the lowest ($P<0.05$) PER value (1.33).

4. Carcass characteristics:

Results in Table 5 exhibited that the dressing percentage of warm carcass (WC) were 65.71, 66.60, 63.16 and 64.60% for rabbits fed on 0, 5, 10 and 15% SBP diets, respectively. However 5% SBP in the diet had resulted in higher WC being (66.60) without significant differences for all treatments. Rabbits fed diets contained different levels of SBP had shown significant differences ($P < 0.05$)for the percentage of fur and trunk, but no significant differences were observed for the percentage of fore limb and hind limb. Heavier ($P < 0.05$) head was observed for rabbits fed diets contained either 0 or 5% SBP (8.12 and 8.52, respectively). Lower ($P < 0.05$) head percentage was recorded for rabbits fed 10 and 15% SBP diets (7.73 and 7.74%, respectively). However, the 5% level of SBP had shown the higher percentage for most edible internal organs, being 2.05, 0.37, 0.71 and 3.42 for liver, heart, kidneys and the total (edible internal organs).

5. Economical evaluation and performance index:

According to the price of different ingredients available in A.R.E at the experimental time (2002-2003) and the local market at the same time, the economical efficiency was calculated. Results given in Table 5 showed that the net return during the 7 weeks of the experimental period were 8.20 and 8.80 LE/ rabbit for rabbits fed on 10 and 15% SBP, respectively. Inclusion of 10 and 15% SBP in the diets resulted in the higher values of economical efficiency (211.34 and 228.57) and performance index of rabbits (50.25 and 54.64), respectively.

From the nutritional and economical point of view, it could be concluded that feeding growing rabbits from 5-12 weeks of age on diets containing 5, 10 and 15% SBP instead of yellow corn decreased the feed cost and increased the economical efficiency.

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Table 1. Composition and chemical analysis of the experiment diets.

Ingredients	Experimental diets			
	0% SBP	5% SBP	10% SBP	15% SBP
Clover hay *	25.60	22	18	15
Sugar beet pulp**	-	5	10	15
Yellow corn	15	10	5	-
Wheat bran	19	20	23	22
Barley	19	19	19	19.80
Soybean meal. (44%)***	16	18.60	19.60	22.80
Molasses	3	3	3	3
Limestone	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Vit & premix****	0.3	0.3	0.3	0.3
D.L Methionine	0.1	0.1	0.1	0.1
Total	100%	100%	100%	100%

Chemical Analysis				
CP%	16.16	16.14	16.52	16.60
EE%	2.45	2.35	2.23	2.15
CF%	12.20	12.35	12.34	12.66
NFE%	64.08	64.12	63.79	63.34
Ash%	5.11	5.04	5.12	5.25
DE. Kcal/kg*****	2682.48	2670.96	2677.16	2650.98

* **clover hay contained (determined):** CP12 %, EE 2.1%, CF30%, 8.8% Ash and DE. Kcal/kg 1780.

** **sugar beet pulp contained (determined):** CP9, EE 1, CF 20, 4.90 Ash and DE Kcal/kg 2818

*** **Soybean meal contained (determined):** CP 44%, EE 1.5, CF 3.7, Ash 6.5% and DE Kcal/kg 3200

**** **vit & premix per kilogram contained:** Coline chloride 200g, Mg 66.70g, CU 0.5g, 33.3mg, Se 16.60mg, Zn 11.79, Fe 12.50g, Vit A 2000000 IU, vit D3 150000 In, vit E 8.33g, vit B1, 0.33g, B6 0.33g, B12 1.7mg, B2 1.0g, B5 8.33g, vit k 0.33 mg, pantotnacic acid 3.33g, Biotin 33 mg and Folic acid 0.83 g.**(cited by Khalil et al. 1996)**

***** Calculated according to NRC for rabbits (1977).

Table 2. Digestibility coefficients and nutritive values of sugar beet pulp (SBP)in rabbits feeding

Item	DM	OM	CP	CF	EE	NFE	Nutritive value		
							DCP	TDN	DE Kcal/kg
Chemical composition	90.00	95.10	9.00	20.00	1.00	65.10			
Average digestibility coefficient			58.19	54.09	76.77	81.94	6.77	73.78	3227

Table3. Digestibility coefficients of rabbits at 12 weeks of age as affected by sugar beet pulp (SBP) at different periods

Treat. group	sugar beet pulp (SBP) level %	Digestibility Coefficient						Nutritive Values		
		DM%	OM%	CP%	CF%	EE%	NFE%	DCP%	TDN%	DE.kcal/kg
		$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE	$\bar{X}$ ±SE
1	0	68.50± 2.77^{a}	69.68± 2.58	66.77± 2.06	43.10± 5.82	80.06± 4.45^{a}	78.99± 1.93	11.88± 0.37	59.91± 2.08	2749.70±98.95
2	5	68.18± 2.48^{a}	68.21± 2.48	66.18± 2.40	40.02± 5.42	74.51± 1.50^{ab}	77.89± 1.86	12.93±0.49	55.35± 1.98	2466.44±86.81
3	10	67.95± 0.48^{ab}	68.56± 0.86	66.57± 0.17	40.12± 0.96	77.08± 3.44^{b}	77.58± 1.30	12.48±0.02	56.50± 0.29	2534.97±27.46
4	15	67.62± 0.36^{ab}	69.23± 0.81	67.10± 1.18	43.60± 1.11	80.36± 3.86^{a}	78.13± 1.62	13.68±0.24	58.49± 0.53	2605.74±24.28

a and bMeans followed by different superscripts in each column, are significantly different at $P > 0.05$

Table4: Growth performance of growing New Zealand white rabbits at 12 weeks of age.

Items	Levels of sugar beet pulp (SBP)			
	0%	5%	10%	15%
Initial number of rabbits	12	12	12	12
Period of experiment (day)	49	49	49	49
Initial live weight (g)	845	850	824	844
Final live weight (g)	b 1911	ab 2002	a 2050	A 2109
Daily weight gain (g)	b 21.67	ab 23.62	a 25.19	A 25.79
Daily feed consumption (g)	b 94.45	ab 95.52	a 96.21	A 96.67
Feed conversion	a 4.36	ab 4.04	ab 3.82	B 3.75
Efficiency of energ utilization (EEU)	a 7.58	b 6.18	b 6.13	B 6.25
Protein efficiency ratio (PER)	b 1.33	a 1.51	a 1.68	A. 1.54

- a and b means within the same raw with different superscripts significantly ($P < 0.05$)

A and B means within the same raw with different superscripts are significantly different ($p<0.01$)

Table5. Some carcass characteristics of rabbits as affected by dietary sugar beet pulp(SBP) at different periods

Treat. group	sugar beet pulp (SBP) level %	Pre- Slaughter weight	Warm carcass (WC) WT %	Fur (F) WT %	Head (H) WT%	Fore limb (FL) WT%	Hind limb (HL) WT%	Trunk (T) WT%	Edible internal organ (EIO)				Boneless meat WT%
									Liver WT%	Heart WT%	Kidney WT%	Total WT%	
1	0	1900.00± 64.55	ab 65.71±0.831	b 11.74±0.39	8.12±0.17	8.20±0.73	19.54±0.44	a 25.17±91	2.27±0.07	0.28±0.01	0.75±0.01	3.29±0.09	82.78
2	5	1975.00±108.97	a 66.60±1.35	ab 12.37±0.76	8.52±0.25	10.46±0.16	20.05±0.49	ab 23.59±0.01	2.05±0.07	0.37±0.05	0.71±0.05	3.42±0.06	80.11
3	10	1995.00± 45.73	b 63.16±0.87	ab 12.63±0.50	7.73±1.77	10.65±0.11	19.14±0.40	b 21.65±0.58	2.34±0.09	0.34±0.08	0.65±0.01	3.32±0.11	79.81
4	15	1980.00± 31.36	b 64.60±0.71	a 13.22±0.33	7.74±0.27	10.04±0.97	19.00±0.75	ab 24.40±0.73	2.21±0.01	0.34±0.03	0.66±0.01	3.21±0.04	78.31

a, b Means in same column with different superscripts are significantly different ($P < 0.05$)

Table 6: Economical evaluation of experimental rations as affected by dietary of sugar beet pulp (SBP) levels.

Items	Treatment groups			
	0% SBP	5% SBP	10% SBP	15% SBP
Live body weight/kg	1.91	2.00	2.05	2.11
Feed intake /kg	4.63	4.67	4.71	4.74
Price of kg diet (P.T)	84.21	83.25	82.37	81.20
Feed cost of gain	3.90	3.89	3.88	3.85
Price of gain	10.68	11.52	12.08	12.65
Net return	6.78	7.63	8.20	8.80
Economic efficiency	173.85	196.14	211.34	228.57
Performance index PI%	42.26	47.32	50.25	54.64

Feeding cost = feed intake per kg x price of kg diet.

- **Price of gain** = gain x 10 (L.E).
- **Net return** = price of gain – feed cost.
- **Economical efficiency** = net return ÷ feed cost x 100

Performance index(PI)= $\frac{\text{Live weight}}{\text{Feed converison}} \times 100$

(According to North 1980)

القيمة الغذائية لبعض المخلفات الزراعية في تغذية الأرانب

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استخدم ٤٨ ذكر أرنب من النوع النيوزيلندي الأبيض عمر خمسة أسابيع في تجربتين أجريت الأولى لمعرفة التركيب الكيماوي والقيمة الغذائية لنفل بنجر السكر كأحد المصادر غير التقليدية في تغذية الأرانب.

أما التجربة الثانية فقد أجريت لمعرفة مدى تأثير إضافة مستويات مختلفة من نفل البنجر (٥، ١٠، ١٥%) على معدل الأداء والكفاءة التحويلية بالإضافة إلى معاملات الهضم وصفات الذبيحة وقد استغرقت فترة التجربة سبعة أسابيع.

أوضحت النتائج أن نفل بنجر السكر يحتوى على ٩% بروتين خام، ٢٠% ألياف خام، ٣٢٢٧ كيلو كالورى/كجم (طاقة مهضومة)، ومعاملات الهضم كانت ٥٩,١٩% بروتين، ٥٤,٠٩% ألياف خام، ٧٦,٧٧% مستخلص الأثير، ٨١,٩٤ المستخلص الخالي من النتروجين.

كانت القيمة الغذائية لنفل البنجر ٦,٧٧% للبروتين المهضوم، ٧٣,٧٨ للمركبات الغذائية المهضومة و٣٢٢٧ كيلو كالورى/كجم طاقة مهضومة كان متوسط الوزن الحي عند نهاية الأسبوع الثاني عشر في نهاية التجربة هي ١٩١٠، ١٩٩٤، ٢٠٥٠، ٢١٠٩.جم للأرانب التي غذيت على صفر، ٥، ١٥،١٠% نفل البنجر على الترتيب.

زاد معدل الكفاءة التحويلية بزيادة نسبة نفل البنجر في العلائق خاصة عند مستوى ١٥% وحقق أعلى معدل كفاءة تحويلية (٣,٧٥) وذلك خلال الفترة الكلية من الأسبوع ٥-١٢ أسبوع .

زاد استهلاك العليقة اليومي بزيادة نسبة نفل البنجر فى العلائق بزيادة نسبة نفل البنجر خلال فترة التجربة وكذلك خلال الفترة الكلية من ٥-١٢ أسبوع.

تحسن معدل كفاءة البروتين عند مستوى إضافة ١٠% نفل بنجر مقارنة بباقي المستويات الأخرى إلا أن العليقة التي خلت من وجود نفل البنجر حققت أعلى معدل كفاءة للبروتين ١,٣٣ وذلك خلال الفترة الكلية من ٥-١٢ أسبوع أمكن الحصول على أعلى معدل تصافي (٦٦,٦٠%) للأرانب التي تم تغذيتها على ٥% نفل بنجر بينما كان معدل تصافي للأرانب التي غذيت على ١٠% نفل بنجر (٦٣,١٦%).

كان أعلى عائد اقتصادي للأرانب المغذاة على ١٥% نفل بنجر وأقل عائد اقتصادي للأرانب المغذاة على عليقة خالية من نفل البنجر.