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EVALUATION OF SUGAR BEET PULP IN FEEDING GROWING RABBITS

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ABSTRACT

This study aimed to evaluate sugar beet pulp (SBP) as a feed source high nutritional value on growing New Zeland White (NZW) rabbits from 6 up to 13 weeks of age. Atotal of 144 weaning rabbits were randomly assigned to 9 similar groups of 16 rabbits each, with 8 replicates for each. Nine isonitrogenous and isoenergetic diets were formulated by substituting, partially or totally, SBP for clover hay (CH) or corn grains (CG) in the control diet. Dietry designations based on the ratios of CH or CG and SBP as follows; 36:0, 27:9, 18:18, 9:27, and 0:36. The results showed that the highest daily weight gain (DWG) and the best feed gain ratio was recorded for rabbits fed on a dite containing SBP with 75% CH substitution, and the diet with substitution of 75% CG by SBP which recorded 5.4% an improvement in feed conversion ratio when compared with those fed the control diet. The interaction between the experimental sources of CH/CG and their experimental levels showed that substituion of CG by SBP at 75% caused the highest lengh of each gastrointestinal tract segments. Empty large intestine weight was heavier, while that of stomac was lighter weight. The interaction between sources of feed substituion (CH/CG) and their levels showed high accumulation of digesta in the large intestine of these rabbits. Nutrients digetibilities were significantly ($P < 0.05$) affected by either substitution of SBP on the expense of CH or CG. Digestion coefficients of nutrients in case of SBP substitution for CG were signficantly higher than those of SBP substitution for CH, except nitrogen free exctract (NFE) (66.36 vs 65.97%). Total digstion nutreint (TDN) and digestable energy (DE) values were signifcantly affected by the source of experimental feedstuff (CH or CG), their levels and the interaction between feedstuffs and their experimental levels.

Keywords: Sugar beet pulp, clover hay, corn grains, digestibility, performance, gastrointestinal organs, pH contents.

INTRODUCTION

The inclusion of alternative sources of fibre in rabbit diets can influence significantly rate of passage, caecal fermentation and soft faeces excretion (Garcia *et al.*, 2000) in some cases, these effects limit their inclusion in rabbit diets. Highly digestive sourecs of fiber such as sugar beet pulp increase caecal acidity but also weight of caecal contents which reduces feed intake and impairs performance (Carabano *et al.*, 1997). Alfalfa is the most widspreed hay included in rabbits diets. Increasing level of alfalfa, whose digestibility effects are well known allow a control of the sanitary condition in the rabbitry and weight improve the nutritive characteristics of the diet (Perez, 1998). Dried beet is a partial source of energy in the rations of livestock (Castle *et al.*, 1966). El-Abed *et al.* (2011) reported that sugar beet pulp and their soluble and insoluble fractions are well digested in young rabbits. They added that the soluble and insoluble fractions of SBP produce different effects in the gastrointestineal tract. In consequence, the aim of this work was to investigate the effect of substitution of SBP for CH and CG in rabbit diets on growth performance, length and weight of each gastrointestinal tract segments, pH values of their contents and nutrients digestibilities.

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MATERIALS AND METHODS

Animals and Experimental Design

One hundred and fourty four New Zealand White rabbits about 6 weeks of age and 600 gm average body weight were randomly assigned in to 9 experimental groups. Each group involved 16 animals with 2 animals in each replicates and were housed in windowed bulding and placed in galvenized wire net (50cm L × 25cm W × 40cm H). Each cage was equipped with an automatic drinker nipple and a manual feeder. The building was naturally lighted and ventilated. The exporimental period lasted up to 13 weeks of age.

Eight experimental diets were fromulated by substitution, partially, or totally, sugar beet pulp (SBP) for clover hay (CH) and corn grain (CG) in an experiment of 4 x 2 factorial design as shown in the following table:

Feedstuff	SBP substitution %					
	Control					
	0		25	50	75	100
Clover Hay (%)	36	36:0	27:9	18:18	9:27	0:36
Corn Grain (%)	36					

The control and experimental diets and their chemical composition are presented in Table 1. All rabbits were kept under similar mangerial and environmental conditions and were offered experimental diets *adlib.*, while clean fresh water was available along the experimental period. Live body weight and feed consumption, were obtained and recorded weakly, while body weight gain and fed conversion were calculated.

At the termination of the experiment, 4 rabbits were randomly chosen from each treatment, fastened for 12 hours before slaughtering and were individually weighted. Animals were slaughtered by cutting the jugular veins of the neck. The weight of full organs of digestive tract, pH of stomach, small intestin, and large one (caecum & colon) were recorded. Also, lengths and weights of full and empty organs measured and were proportioned to the live pre-slaughtering weight. Also, ten digestion trails using 4 animals per group were carried out to evaluate the digestibility coefficients and feeding values of SBP and the experimental diets. Animals were individually housed in metabloism cages that allowed separation of feces and urine. After a preliminary period, feces were daily collected at fixed time in the morning on the four consecutive days, sprayed with 2% boric acid to trap ammonia released, then dried at 60° C for 24 hrs in air drying oven. Feces were finely ground and mixed to insure sample uniformity and then stored for further chemical analysis.

Chemical Analyses

Feeds and feces samples were air dried at 105°C to constant weight to estimate the dry matter content. Proximate analysis of experimental diets and feces were carried out to determine crude protein (CP), ether extract (EE), crude fiber (CF) and ash content according to (A.O.A.C 1995). Acid detergent fibre (ADF), acid detergent lignin (ADL) and neutral detergent fibre (NDF) were determined according to the secquential procedure of Van Soest *et al.* (1991). Lignin was determined by treatment of ADF with 72% (w/w) H_2So_4.

Statistical Analysis

Data were statistically analyzed on a randomized complete design basis with a control diet and 2x4 factorial arrangements using the General Linear Model (GLM) procedure of SAS program (SAS, 2002).

RESULTS AND DISCUSSION

Chemical Composition of Sugar Beet Pulp (SBP)

Chemical composition of the evaluated SBP is summarized in Table 2. The results showed that SBP contained 89.68, 93.92, 8.6, 23.11, 0.51, 61.7 and 6.08% for DM, OM, CP, CF, EE, NFE and ash, respectively. It is worthy to note that SBP has a considerable amounts of NFE and CF, but it showed lower values of CP (8.6%) and EE (0.51%) percentages. Morisson (1959) reported that SBP is considered low in protein content, high in fiber content and deficient in fat which have been reported as a reason for lower availability of the nutrients in SBP. The containing SBP higher values of CF and ash, but nearly equal content of CP and DM compared with corn grains (Abedo 2006). He added that, at 10% CP and 18% CF, beet pulp sits hight on the edge between being a forage and an energy feed.

Table 1. Components and determined chemical composition of experimental diets (on %DM basis)

Items	Control	SBP substitution (25, 50, 75, 100%) for CH or CG							
	0 : 36	9 : 27		18 : 18		27 : 9		36 : 0	
	S:H or Y	S:H	S:Y	S:H	S:Y	S:H	S:Y	S:H	S:Y
Components (%)									
Sugar Beet Pulp (S)	-	9.00	9.00	18.00	18.00	27.00	27.00	36.00	36.00
Clover Hay (H)	36.00	27.00	30.00	18.00	22.00	9.00	14.00	-	6.00
yellow corn (Y)	36.00	28.00	27.00	19.00	18.00	13.00	9.00	8.50	-
Soybean meal (44%)	15.20	14.90	14.80	14.40	14.50	14.50	14.00	15.00	13.60
Wheat bran	6.70	15.00	13.10	24.50	21.40	30.40	29.90	34.40	38.30
Molasses	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
DL-Methionine	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit. & Min. Premix (1)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt (Nacl)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analyses (2)									
DE, Kcal / Kg	2891	2852	2814	2799	2754	2788	2693	2799	2632
Calcium %	0.51	0.47	0.50	0.42	0.47	0.38	0.43	0.34	0.40
Phosphor %	0.36	0.43	0.40	0.51	0.47	0.56	0.55	0.59	0.62
Sulpher amino acid %	0.65	0.65	0.65	0.65	0.65	0.66	0.64	0.66	0.64
Lysine %	0.75	0.78	0.78	0.80	0.81	0.83	0.84	0.87	0.87
Cell wall constituents, %									
NDF	29.11	29.95	30.15	29.95	30.16	30.16	30.55	30.13	30.48
ADF	18.51	20.41	20.35	20.15	18.95	19.93	19.14	19.65	19.44
ADL	4.72	4.92	4.81	4.61	4.11	4.59	4.19	4.83	4.76
Determined Chemical Comosition									
DM	94.41	94.06	94.25	94.19	93.99	94.36	94.16	94.28	93.89
OM	90.15	89.47	90.70	90.25	89.97	90.45	90.21	89.60	90.05
CP	16.11	15.87	16.09	16.11	16.04	16.21	16.12	15.97	15.98
CF	14.01	14.02	14.42	13.99	14.15	13.78	14.25	13.12	14.62
EE	1.64	1.65	1.71	1.84	1.74	1.78	1.65	2.01	1.59
NFE	62.65	62.52	62.03	62.25	62.06	62.59	62.14	63.18	61.70
Ash	5.59	5.94	5.75	5.81	6.01	5.64	5.84	5.72	6.11
Cost / Kg diet PT, (Local prices of 2011) (3)	1.67	1.61	1.58	1.53	1.50	1.48	1.42	1.44	1.34

(1)Grower Vit. & Min. Premix : Each Kg consists: vit. A 2.000.000 IU, vit. D_3 150.000 IU, vit. E 8.33 g, vit. K 0.33 g, vit. B_1 0.33 g, vit. B_2 1.0 g, vit. B_6 0.33 g, vit. B_{12} 1.7 mg, pantothenic acid 3.33 g, Biotin 33 mg, Folic acid 0.83 g, Choline chloride 200 g, Zn 11.7 g, Mn 5 g, Fe 12.5 g, Cu 0.5 g, I 33.3 mg, Se 16.6 mg, and Mg 66.7 g.

(2)Calculated according to NRC (1977).

(3)Based upon each unit weight (Kg) of sugar beet pulp, clover hay, soybean meal, yellow corn, wheat bran, molases, DL-methionine, Vit. & Min. premix and salt (Nacl) equals to 1250.0, 1300.0, 3000.0, 2000.0, 1500.0, 600.0, 35000.0, 10000.0 and 250.0 PT.

Table 2. Chemical composition, digestibility coefficients and feeding values of SBP

Items	Chemical composition % DM basis)	Digestibility coefficient %
Determined Composition		
DM	89.68	50.91
OM	93.92	56.54
CP	8.60	74.69
EE	0.51	75.09
CF	23.11	26.55
NFE	61.7	65.88
Ash	6.08	--
Cell wall constituents, %		
NDF	50.60	
ADF	27.47	
ADL	2.01	
Hemicellelose	23.13	
cellulose	25.46	
CCnN	34.72	
Feeding value (as fed):		
TDN %		50.59
DE, Kcal / kg		2241.14
DCP		6.84

DM = Dry matter, OM = Organic matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber, NFE = Nitrogen free, extract, NDF = Neutral detergent fiber, ADF = Acid detergent fiber and ADL = Acid detergent lignin, TDN = Total digestible nutrients, DCP = Digestible crude protein

Further more, in pigs (Zhu *et al.* 1990) has shown that substitution of SBP for cereals decreased the efficincy of conversion of DE for growth, consequently, use of digestible energy (DE) instead of net energy (NE) might over estimate the energy value of SBP in nonruminant species.

Cell Wall Constituents of SBP

The evaluated SBP contained 50.60, 27.47, 2.01, 23.13, 25.46, and 34.72% for NDF, ADF, ADL, Hemicellelose, cellulose and non-nitrogenous cellular content respectively. The present values are comparable with that of the previous investigators as shown in Table 2.

Nigam (1994) reported that the SBP contained 20% cellulose, 30% hemicellulose, 16% pectin and 4% lignin. Shwarz *et al.* (1995) maintion that SBP contains mainly easily degradable structure carbohydrate (cellulose, hemicellulose, pectin pentosans), while the main carbohydrate in maize and wheat or oats is starch. Sun and Hughes (1998) pointed that SBP on a dry weight basis contains 65-80% polysaccharides, consisting roughly 40% cellulose, 30% hemicellulose and 30% pectin. Varhegyi *et al.* (2002) found that SBP contained 64.2% NDF, 33.3% ADF and 2.5% ADL and contained 13.6% acid detergent insoluble protein (ADSP) as persentage of total CP. Diets for SBP substitution % for hay gave higher NDF, ADF, ADL and cellulose than that of control diet, while diets for SBP substitution % for CG recorded higher NDF, ADF, ADL, hemicellulose and cellulose than that of control diet. ADL/celulose in CH/CG diets was lower than that of control diet and the vice versa in case of non- nitrogenous cellular content value.

Nutrients Digestibility and Feeding Value of SBP

Results in Table 2 showed that digestibility coefficients of nutrients in SBP were 50.91, 56.54, 74.69, 75.09, 26.55 and 65.88% for DM, OM, CP, EE, CF and NFE, respectively.

The nutritive values of the evaluated SBP were 50.59%, 2241.14 kcal/kg and 6.84% for TDN, DE and DCP, respectively. A similer variation (2.15 vs 2.67 kcal of DE/g) was reported previously (Blas and Villamide, 1990) when the DE content of SBP was determined by substituting basal diets containing medium or low levels of fiber, respectively. The increase of DE content with level of inclusion of SBP could be explained by a longer retention time of the digesta in the gut, as observed by other authers (Candau *et al.* 1979; Fioramonti *et al.* 1997; Fraga *et al.*, 1991).

Growth Performance

Daily weight gain (DWG), daily feed intake (DFI) and feed conversion ratio (FCR) of NZW rabbits as affected by SBP from 6-13 weeks of age are reported in Table 3. Either CH or YC substitution of SBP showed a significant effect ($P < 0.05$) on daily weight gain. The substitution of SBP for CH recorded the higher value of DWG than that of CG. The highest DWG was obtained in case of 75% substitution of SBP, while the lowest value were recorded for rabbits fed on 100% substituion of SBP. The interaction between level and source (CH/YC) showed that the highest DWG was shown in case of rabbits fed on a diet containing SBP with 75% CH substitution, while the lowest record was for rabbits fed on a diet containing SBP with 100% YC substitution. Data in the present study showed non significant differences in feed cnsumption among all of the different experemintal groups. The highest feed consumption in this result in group that fed on SBP wite 25% CH substitution diet, while the least one was that group fed on SBP wite 75% CH substitution diet.

Feed conversion ratio was significantly ($P < 0.01$) affected by either CH/YC substitution and also the interaction between the experimental sources (CH/YC) and their levels. Feed utilization was improved by substitution of CH by SBP more than that of substitution of CG b SBP as shown in Table 3. The best feed gain ratio was obtained at 75% SBP substitution.

The interaction bettween the sources of CH/CG and their levels showed that substitution of CH by SBP at 75% showed the best feed gain ratio, while the worst record was for 100% SBP substitution for CG. It is worthy noting that rabbits fed a diet with substitution of 75% of corn grain by SBP recorded 5.4% an improvement in feed conversion ratio when compared with those fed the control diet.

In conclusion, the highest DWG and best feed : gain ratio of rabbits fed on a diet contains SBP with 75% CH substitution.

Effect of Substitution of SBP for CH/CG on Gastrointestinal Tract Segments of Growing NZW Rabbits at 13 Weeks of Age

The results obtained on gastrointestinal tract at 13 weeks of age is presented in Table 4. The substitution of SBP for CG in the expermental diets increased the length of each part of the gastrointestinal tract (stomach, small intestine and large intestine) more than that substitution for CH as shown in Table 4. Analysis of variance indicated that there was significant differences either between source CH/CG or between there experemental levels as shown in Table 4. The interaction between the experimental sources of CH/CG and their expermental levels showed that substitution of CG by SBP at 75% showed the highest length of each gastrointestinal tract segments. It is worthy noting that the length of total digestive tract stomach, small intestin and large intestin in case of substitution of SBP for 100% CH was 544.11, 29.46, 333.40 and 181.25 cm respectevly, being higher than that substitution of 100% CG with SBP.

El Abed *et al.* (2011) repored that when they compared SBP diet with their soluble or insoluble fractions, the insoluble fraction seems to be the main responsible of the high total digestive tract weight. They added that the soluble and insoluble fractions of SBP produce different effects on the gastrointestinal tract.

Xiceato *et al.* (2003) reported that the early weaned rabbits successfully preformed at 21 days of age strongly stimulated caecal fermentation but reduced body protein resurces. They added that the greater the weaning age, the higher the pH of the caecal contents and lower the total VFA concentration.

Table 3. Growth performance of New Zealand White rabbits ($\overline{X}$ ±SE) as affected by Sugar Beet Pulp (SBP) during the experimental period.

Items	Live body weight (g) at:		Daily BWG	Daily FI	FC
	6 weeks (Initial)	13 weeks (final)	(g)	(g)	(g feed / g gain)
SBP substitution % for:					
Hay	607.97 ± 0.40	2582.50 ± 11.75	35.33 ± 0.22	117.36 ± 0.26	3.45 ± 0.03
Grain	608.20 ± 0.56	2498.13 ± 11.37	33.59 ± 0.20	117.35 ± 0.50	3.61 ± 0.03
Significance	NS	**	**	NS	**
SBP substitution %:					
25%	607.97 ± 0.57	2523.44 ± 8.08	34.26 ± 0.15^{b}	117.99 ± 0.63	3.56 ± 0.02^{b}
50%	608.13 ± 0.48	2566.72 ± 11.88	34.70 ± 0.30^{b}	117.51 ± 0.51	3.47 ± 0.02^{c}
75%	608.13 ± 0.84	2604.44 ± 17.66	35.65 ± 0.31^{a}	116.95 ± 0.26	3.38 ± 0.03^{d}
100%	608.13 ± 0.84	2466.66 ± 18.99	33.24 ± 0.40^{c}	116.98 ± 0.74	3.72 ± 0.04^{a}
Significance	NS	NS	**	NS	**
Treatments					
0 % (Control)	607.50 ± 0.94	2469.00 ± 5.35^{e}	33.29 ± 0.13^{e}	118.28 ± 1.32	3.70 ± 0.04^{b}
25% SBP for hay	607.81 ± 0.74	2545.63 ± 6.79^{c}	34.60 ± 0.12^{c}	118.44 ± 0.28	3.53 ± 0.01^{cd}
50% SBP for hay	607.81 ± 0.74	2603.13 ± 2.74^{b}	35.63 ± 0.04^{b}	117.55 ± 0.37	3.39 ± 0.01^{e}
75% SBP for hay	608.13 ± 0.91	2664.19 ± 16.10^{a}	36.72 ± 0.28^{a}	116.54 ± 0.32	3.26 ± 0.02^{f}
100% SBP for hay	608.13 ± 0.91	2517.06 ± 17.73^{cd}	34.38 ± 0.49^{cd}	116.91 ± 0.77	3.61 ± 0.06^{bc}
25% SBP for grain	608.13 ± 0.91	2501.25 ± 9.65^{de}	33.92 ± 0.23^{cde}	117.53 ± 1.24	3.59 ± 0.04^{cd}
50% SBP for grain	608.44 ± 0.66	2530.31 ± 14.80^{cd}	33.77 ± 0.36^{de}	117.46 ± 0.99	3.55 ± 0.02^{cd}
75% SBP for grain	608.13 ± 1.48	2544.69 ± 7.54^{c}	34.58 ± 0.11^{c}	117.36 ± 0.37	3.50 ± 0.01^{d}
100% SBP for grain	608.13 ± 1.48	2416.25 ± 22.49^{f}	32.10 ± 0.25^{f}	117.05 ± 1.33	3.82 ± 0.04^{a}
Significance	NS	**	**	NS	**

Means in the same column within each classification bearing different letters are significantly (P<0.05) different.

** P < 0.01 and N.S = Not significant

Table 4. Digestive system length of New Zealand White rabbits ($\overline{X}$ ±SE) as affected by Sugar Beet Pulp (SBP) at 13 weeks of age

Items	Body weight (g.)	Length (cm.)				
		Body	Digestive tract	Stomach	Small intestine	Large Intestine
SBP substitution % for:						
Hay	2562.00 ±14.65	50.80 ± 0.55	548.61 ± 0.83	30.96 ± 0.26	334.90 ± 0.33	182.75 ± 0.32
Grain	2490.94 ±14.24	50.90 ± 0.58	548.99 ± 1.12	31.09 ± 0.36	335.03 ± 0.41	182.88 ± 0.41
Significance	**	NS	NS	NS	NS	NS
SBP substitution %:						
25%	2508.75 ±7.18 ab	50.71 ± 0.85	548.61 ± 0.61 b	30.96 ± 0.15 c	334.90 ± 0.32 b	182.75 ± 0.31 b
50%	2560.00 ±19.23 a	51.28 ± 0.74	550.86 ± 0.67 a	31.71 ± 0.17 b	335.65 ± 0.34 ab	183.50 ± 0.33 ab
75%	2555.88 ±28.47 a	50.84 ± 0.88	552.36 ± 0.67 a	32.21 ± 0.17 a	336.15 ± 0.34 a	184.00 ± 0.33 a
100%	2481.25 ±25.63 b	50.58 ± 0.80	543.36 ± 0.67 c	29.21 ± 0.17 d	333.15 ± 0.34 c	181.00 ± 0.33 c
Significance	**	NS	**	**	**	**
Treatments						
0 % (Control)	2411.25 ±56.32 d	50.83 ± 1.39	545.61 ± 0.93 d	29.96 ± 0.23 d	333.90 ± 0.48 bcd	181.75 ± 0.48 bc
25% SBP for hay	2523.75 ±3.15 bc	50.75 ± 1.22	548.61 ± 0.92 c	30.96 ± 0.22 c	334.90 ± 0.49 abc	182.75 ± 0.49 ab
50% SBP for hay	2593.75 ±6.25 ab	50.98 ± 1.26	550.11 ± 0.92 bc	31.46 ± 0.24 bc	335.40 ± 0.46 ab	183.25 ± 0.47 ab
75% SBP for hay	2626.75 ±20.51 ab	50.83 ± 1.42	551.61 ± 0.96 ab	31.96 ± 0.22 ab	335.90 ± 0.49 a	183.75 ± 0.48 a
100% SBP for hay	2503.75 ±21.64 bc	50.65 ± 0.94	544.11 ± 0.92 de	29.46 ± 0.22 de	333.40 ± 0.47 cd	181.25 ± 0.48 c
25% SBP for grain	2493.75 ±8.98 cd	50.68 ± 1.37	548.61 ± 0.92 c	30.96 ± 0.22 c	334.90 ± 0.47 abc	182.75 ± 0.48 ab
50% SBP for grain	2526.25 ±30.44 bc	51.58 ± 0.95	551.61 ± 0.95 ab	31.96 ± 0.28 ab	335.90 ± 0.49 a	183.75 ± 0.48 a
75% SBP for grain	2485.00 ±3.54 cd	50.85 ± 1.25	553.11 ± 0.92 a	32.46 ± 0.22 ab	336.40 ± 0.49 a	184.25 ± 0.48 a
100% SBP for grain	2458.75 ±47.54 cd	50.50 ± 1.45	542.61 ± 0.92 e	28.96 ± 0.24 e	332.90 ± 0.50 d	180.75 ± 0.49 c
Significance	**	NS	**	**	**	**

Means in the same column within each classification bearing different letters are significantly ($P < 0.05$) different.

** $P < 0.01$ and N.S = Not significant

Effect of Substitution of SBP for CH/CG on Gastrointestinal Organs (GIO) Weight, their Content Weight and pH Value (of Growing NZW Rabbits) at 13 Weeks of Age

Effect of substitution of SBP for CH/CG on GIO weight and their content are shown in Table 5. In this study neither CH/CG nor their levels had significant effect on empty digestive tract weight or their content. Falcao *et al.* (2004) reported that beet pulp diets gave heavier stomachs and caecums. It is worthy noting that the interaction between source of feed substitution (CH/CG) and their levels showed high accumulation of digesta in the large intestin of these rabbits.

This was probably caused by high accumulation of digesta in the caecum of these rabbits. These results are in good agreement with that of Gutierrz *et al.* (2002). It is noticed that the high accumulation of digesta in the caecum of these rabbits caused the lowest feed intake (116.54 g/d). On the other hand rabbits which ware fed on 75% SBP substitution for CG caused lowest accumulation of digest in the caecum (13.92%) and highest feed consumption (117.46 g/d). An additional reason may be the low of ADL/cellulose ratio which was only 0.30 in 75% SBP for hay ration. It is worthy noting that Gidenne *et al.* (2001) reported a decrease in voluntary feed intake in rabbits with a decrease of ADL/cellulose level. Fibre nature affects total transit time and particularly the time spnt in the caecum (Gidenne, 1987; Garciae *et al,* 1999).

The pH of GIO contents was not affected by 100% substitution basis, when 25, 50, 75 or 100% of SBP was added at expeuse of clover hay or corn grain as shown in Table 5. On the other hand Falcaoe *et al.* (2004) found that the pH of caecal contents was significantly affected by the source of fibre being lower in beet pulp diets.. El Abed *et al.* (2011) studied the effect of the different fibre components of SBP on growth performance and some digestive traits. They found that the type of diet did't affected on growth rate and stomach pH. They added that the inclusion of SBP or their fractions decreased the caecal pH.

The Apparent Digestibility and the Nutritive Values of the Experimental Diet in NZW Rabbits as Affected by SBP Substitution at 13 Weeks of Age

Table 6. presents nutrients digestibilities and nutritive values of the different experimental diets. Results indicated that nutrients digestibilities were significantly ($P > 0.05$) affected by either substitution of SBP (CH or CG). Digestion coefficients of nutrients in case of SBP substitiution for CG were significantly higher than those of SBP substitution for CH, exept digestion coefficient of NFE. (66.36 vs 65.97%). Digestion coefficients were significantly influenced by SBP substitution levels as shown in Table 6. Digestion coefficient tended significantly tended to increase by 50% SBP substitution in case of CF, while it tended to increase by 75% SBP substitution in case of CP and NFE digetibility. The interaction between the two experimented feedstuffs (CH/CG) and their substitutin levels indicated the presence of significant.

TDN and DE values were significantly affected by the source of experimental feedstuff (CH or CG), their levels and the interaction between feedstuff and theis experimental levels. It is worthy noting that DE increased gradually when 25, 50 and 75% of SBP was added at the expense of CH as shown in Table 6, while in case of substitution of SBP for CG, DE increaced only from 25 to 50% SBP substitution. The increase of DE content with level of inclusion of SBP could be explained by a longer retention time of the digesta in the gut, as observed by (Garcia *et al.* 1993; Fraga *et al.* 1991). It is clear that increasing the substitution of SBP up to 100% by either CH or CG decreased the DE content of the diet. The substitution of SBP for CG primarily results in a replacement of starch with highly termentable cell wall components. Garcia *et al.* (1993) reported that overall effect on nutrient digestion was a decrease of dietary DE of 137, 276 and 262 kcal/kg or 913, 789 and 524 kcal/kg on 100% substitution basis when 15.35 or 50% of SBP was added at expeuse of barley grain.

Table 5. Digestive tract organs of New Zealand White rabbits ($\overline{X}$ ±SE) as affected by Sugar Beet Pulp (SBP) at 13 weeks of age

Items	Slughter Wt.	Digestive tract Wt. %		Stomach Wt. % & pH			Small intestine Wt. % & pH			Large intestine Wt. % & pH			
		Empty	Content	Empty	Content	pH value of content	Empty	Content	pH value of content	Empty	Content	pH value of content Caecum	pH value of content Colon
SBP substitution % for:													
Hay	2562.00	5.13 ±0.01	14.01 ±0.05	1.10 ±0.01	2.46 ±0.02	1.66 ±0.03	1.97 ±0.01	0.88 ±0.01	7.22 ±0.03	2.73 ±0.01	14.18 ±0.04	6.09 ±0.04	6.51 ±0.03
Grain	2490.94	5.11 ±0.02	13.89 ±0.04	1.10 ±0.01	2.45 ±0.02	1.61 ±0.03	1.97 ±0.01	0.87 ±0.01	7.22 ±0.03	2.72 ±0.01	14.04 ±0.05	6.10 ±0.03	6.50 ±0.03
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SBP substitution %:													
25%	2508.75	5.11 ±0.01	13.93 ±0.02	1.10 ±0.01	2.45 ±0.02	1.60 ±0.05	1.97 ±0.01	0.87 ±0.01	7.18 ±0.03	2.72 ±0.01	14.13 ±0.04	6.08 ±0.05	6.50 ±0.04
50%	2560.00	5.12 ±0.04	13.94 ±0.06	1.10 ±0.02	2.45 ±0.02	1.61 ±0.04	1.96 ±0.02	0.88 ±0.01	7.21 ±0.04	2.73 ±0.01	14.06 ±0.07	6.15 ±0.05	6.50 ±0.05
75%	2555.88	5.13 ±0.01	13.99 ±0.11	1.10 ±0.02	2.46 ±0.04	1.68 ±0.03	1.97 ±0.01	0.88 ±0.02	7.24 ±0.05	2.73 ±0.01	14.13 ±0.09	6.09 ±0.04	6.50 ±0.04
100%	2481.25	5.13 ±0.02	13.94 ±0.06	1.10 ±0.01	2.44 ±0.02	1.65 ±0.04	1.98 ±0.01	0.87 ±0.02	7.25 ±0.07	2.73 ±0.01	14.14 ±0.06	6.08 ±0.05	6.51 ±0.04
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Treatments													
0 % (Control)	2411.25	5.13 ±0.01	13.94 ±0.09	1.10 ±0.01	2.46 ±0.03	1.68 ±0.03	1.97 ±0.01	0.88 ±0.02	7.18 ±0.03	2.73 ±0.01	14.05 ±0.10 ^{bc}	6.10 ±0.04	6.53 ±0.03
25% SBP for hay	2523.75	5.11 ±0.02	13.94 ±0.04	1.09 ±0.01	2.47 ±0.02	1.65 ±0.06	1.97 ±0.02	0.87 ±0.02	7.18 ±0.05	2.73 ±0.00	14.12 ±0.07 ^{abc}	6.10 ±0.09	6.50 ±0.04
50% SBP for hay	2593.75	5.12 ±0.04	14.03 ±0.08	1.10 ±0.03	2.45 ±0.03	1.65 ±0.06	1.96 ±0.02	0.89 ±0.02	7.20 ±0.04	2.74 ±0.02	14.20 ±0.08 ^{abc}	6.13 ±0.09	6.50 ±0.07
75% SBP for hay	2626.75	5.14 ±0.02	14.15 ±0.17	1.11 ±0.03	2.45 ±0.08	1.68 ±0.03	1.97 ±0.02	0.88 ±0.04	7.23 ±0.05	2.74 ±0.01	14.33 ±0.09 ^{a}	6.08 ±0.05	6.50 ±0.09
100% SBP for hay	2503.75	5.13 ±0.03	13.93 ±0.07	1.10 ±0.01	2.46 ±0.03	1.65 ±0.06	1.98 ±0.02	0.87 ±0.02	7.28 ±0.11	2.73 ±0.00	14.09 ±0.04 ^{abc}	6.08 ±0.09	6.53 ±0.06
25% SBP for grain	2493.75	5.10 ±0.02	13.92 ±0.03	1.11 ±0.02	2.44 ±0.04	1.55 ±0.06	1.97 ±0.02	0.87 ±0.02	7.18 ±0.03	2.70 ±0.03	14.15 ±0.06 ^{abc}	6.05 ±0.06	6.50 ±0.07
50% SBP for grain	2526.25	5.12 ±0.08	13.85 ±0.08	1.10 ±0.03	2.45 ±0.03	1.58 ±0.03	1.96 ±0.04	0.88 ±0.01	7.23 ±0.09	2.73 ±0.01	13.99 ±0.01 ^{c}	6.18 ±0.06	6.50 ±0.08
75% SBP for grain	2485.00	5.11 ±0.02	13.84 ±0.11	1.10 ±0.02	2.46 ±0.04	1.68 ±0.05	1.96 ±0.02	0.88 ±0.01	7.25 ±0.09	2.72 ±0.02	13.92 ±0.08 ^{c}	6.10 ±0.06	6.50 ±0.00
100% SBP for grain	2458.75	5.13 ±0.02	13.95 ±0.11	1.10 ±0.01	2.43 ±0.02	1.65 ±0.06	1.97 ±0.02	0.87 ±0.03	7.23 ±0.09	2.74 ±0.01	14.19 ±0.12 ^{abc}	6.08 ±0.05	6.50 ±0.04
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS

Means in the same column within each classification bearing different letters are significantly ($P < 0.05$) different.
$P < 0.05$ and N.S = Not significant

Table 6. Digestibility coefficients and nutritive values of New Zealand White rabbits ($\overline{X}$ ±SE) as affected by Sugar Beet Pulp (SBP) at 13 weeks of age

Items	Digestion coefficients						Nutritive values (As feed)		
	DM	OM	CP	EE	CF	NFE	DCP	TDN	DE, Kcal / kg
SBP substitution % for:									
Hay	61.45 ± 0.15	64.00 ± 0.30	75.27 ± 0.18	77.53 ± 0.29	32.74 ± 0.22	66.36 ± 0.26	13.57 ± 0.12	52.25 ± 0.27	2314.54 ± 12.16
Grain	62.31 ± 0.30	65.05 ± 0.15	75.29 ± 0.20	78.66 ± 0.08	32.87 ± 0.17	65.97 ± 0.25	12.75 ± 0.07	51.27 ± 0.25	2271.45 ± 11.13
Significance	*	*	NS	**	NS	**	**	**	**
SBP substitution %:									
25%	61.89 ± 0.24	64.40 ± 0.46	75.26 ± 0.11 ^{c}	78.51 ± 0.08	33.07 ± 0.10 ^{ab}	66.12 ± 0.09 ^{c}	12.98 ± 0.16	51.55 ± 0.14 ^{b}	2283.61 ± 6.40 ^{b}
50%	61.68 ± 0.33	64.03 ± 0.48	75.61 ± 0.12 ^{b}	78.20 ± 0.25	33.28 ± 0.41 ^{a}	66.65 ± 0.12 ^{b}	13.25 ± 0.16	52.49 ± 0.27 ^{a}	2325.42 ± 12.03 ^{a}
75%	62.54 ± 0.47	64.61 ± 0.30	75.99 ± 0.11 ^{a}	78.01 ± 0.46	32.46 ± 0.16 ^{b}	67.24 ± 0.14 ^{a}	13.35 ± 0.33	52.56 ± 0.35 ^{a}	2328.35 ± 15.52 ^{a}
100%	61.42 ± 0.31	65.04 ± 0.19	74.25 ± 0.13 ^{d}	77.65 ± 0.47	32.41 ± 0.22 ^{b}	64.65 ± 0.12 ^{d}	13.05 ± 0.08	50.44 ± 0.30 ^{c}	2234.60 ± 13.22 ^{c}
Significance	NS	NS	**	NS	*	**	NS	**	**
Treatments									
0 % (Control)	60.63 ± 0.16 ^{d}	63.83 ± 0.42 ^{abc}	74.50 ± 0.09 ^{e}	78.33 ± 0.17 ^{ab}	34.46 ± 0.45 ^{a}	65.27 ± 0.05 ^{e}	12.79 ± 0.17 ^{def}	50.25 ± 0.12 ^{ef}	2226.08 ± 5.17 ^{ef}
25% SBP for hay	61.28 ± 0.02 ^{cd}	63.72 ± 0.77 ^{bc}	75.16 ± 0.12 ^{d}	78.55 ± 0.06 ^{ab}	32.90 ± 0.10 ^{b}	66.13 ± 0.10 ^{d}	13.28 ± 0.18 ^{c}	51.79 ± 0.07 ^{cd}	2294.30 ± 3.15 ^{cd}
50% SBP for hay	60.96 ± 0.38 ^{cd}	63.02 ± 0.52 ^{c}	75.50 ± 0.18 ^{bcd}	77.65 ± 0.27 ^{bc}	33.33 ± 0.72 ^{b}	66.80 ± 0.22 ^{bc}	13.66 ± 0.07 ^{b}	52.81 ± 0.21 ^{ab}	2339.59 ± 9.10 ^{ab}
75% SBP for hay	61.71 ± 0.27 ^{bcd}	64.38 ± 0.45 ^{abc}	76.05 ± 0.16 ^{a}	77.15 ± 0.68 ^{c}	32.41 ± 0.24 ^{b}	67.57 ± 0.14 ^{a}	14.20 ± 0.10 ^{a}	53.40 ± 0.32 ^{a}	2365.51 ± 14.26 ^{ab}
100% SBP for hay	61.86 ± 0.27 ^{bcd}	64.88 ± 0.33 ^{ab}	74.38 ± 0.23 ^{e}	76.77 ± 0.70 ^{c}	32.30 ± 0.38 ^{b}	64.92 ± 0.11 ^{e}	13.15 ± 0.04 ^{cd}	50.99 ± 0.46 ^{de}	2258.75 ± 20.29 ^{de}
25% SBP for grain	62.49 ± 0.14 ^{ab}	65.09 ± 0.28 ^{ab}	75.37 ± 0.19 ^{cd}	78.48 ± 0.17 ^{ab}	33.24 ± 0.14 ^{b}	66.11 ± 0.16 ^{d}	12.69 ± 0.17 ^{ef}	51.31 ± 0.23 ^{d}	2272.92 ± 10.24 ^{de}
50% SBP for grain	62.41 ± 0.07 ^{ab}	65.05 ± 0.32 ^{ab}	75.73 ± 0.16 ^{abc}	78.76 ± 0.12 ^{ab}	33.23 ± 0.51 ^{b}	66.51 ± 0.09 ^{c}	12.85 ± 0.11 ^{def}	52.17 ± 0.48 ^{bc}	2311.24 ± 21.42 ^{bc}
75% SBP for grain	63.36 ± 0.73 ^{ab}	64.84 ± 0.42 ^{ab}	75.93 ± 0.15 ^{ab}	78.88 ± 0.19 ^{a}	32.50 ± 0.25 ^{b}	66.90 ± 0.03 ^{bc}	12.50 ± 0.09 ^{f}	51.72 ± 0.02 ^{cd}	2291.20 ± 1.04 ^{cd}
100% SBP for grain	60.98 ± 0.49 ^{cd}	65.20 ± 0.22 ^{a}	74.13 ± 0.14 ^{e}	78.53 ± 0.07 ^{ab}	32.53 ± 0.27 ^{b}	64.38 ± 0.05 ^{f}	12.96 ± 0.15 ^{cde}	49.90 ± 0.09 ^{f}	2210.46 ± 3.90 ^{f}
Significance	**	*	**	**	**	**	**	**	**

Means in the same column within each classification bearing different letters are significantly ($P < 0.05$) different.

*$P < 0.05$, ** $P < 0.01$ and N.S = Not significant

Conclusion

Performance results showed that the highest DWG was in case of rabbits fed on a diet containing SBP with 75 % CH substitution and the best feed gain ratio was obtained at 75% SBP substitution with CH or CG. Rabbits which were fed on 75% SBP substitution for CG caused lowest accumulation of digesta in the caecum and the highest feed consumption. Increasing the substitution of SBP up to 100% by either CH or CG decreased the DE content of the diet.

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تقييم تفـل بنجـر السـكر فـي تغـذية الأرانب النـاميـة

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تهدف هذه الدراسة الى تقييم تفل بنجر السكر (SBP) كمصدر غذائي مرتفع القيمة الغذائية في تغذية الأرانب النيوزيلندي الأبيض خلال الفترة من ٦ – ١٣ أسبوع . أستُخدم لذلك ١٤٤ أرنب نيوزيلندي أبيض في عمر الفطام ، قُسمت إلى ٩ مجموعات تجريبية بكل منها ١٦ أرنب تم توزيعها على ٨ مكررات بكل مجموعة. كُونت ثمان علائق تجريبية متساوية الطاقة والبروتين حل فيها تفل بنجر السكر جزئياً أو كلياً محل الدريس أو حبوب الذرة في العليقة الكونترول ، وكانت نسب إحلال تفل بنجر السكر محل الدريس/حبوب الذرة وزن بوزن كالتالي: ٠:٣٦، ٩:٢٧، ١٨:١٨ ، ٩:٢٧ ، ٣٦:٠. أظهرت النتائج أن التغذية على نسبة إحلال ٧٥٪ تفل بنجر السكر محل دريس العليقة (٢٧ : ٩) أعطى أعلى زيادة في وزن الجسم وأفضل معدل تحويل غذائي ، كما أن التغذية على نسبة إحلال ٧٥٪ تفل بنجر السكر محل حبوب الذرة (٢٧ : ٩) أعطى تحسناً قدره ٥,٤٪ في معدل تحويل الغذاء بالمقارنة بالمجموعة الكونترول (٠ : ٣٦)، كذلك التداخل بين نسب الإحلال التجريبية أظهر أن نسبة إحلال ٧٥ ٪ تفل بنجر السكر محل الدريس/حبوب الذرة أدى إلى زيادة طول كل قطاعات القناة الهضمية وزيادة وزن الأمعاء الغليظة وإنخفاض وزن المعدة . التداخل بين إحلال تفل بنجر السكر محل الدريس/حبوب الذرة والمستويات التجريبية أظهر تراكم مواد هضمية في الأمعاء الغليظة للأرانب ، كما أزداد تأثر معاملات هضم الغذاء باستبدال الدريس بتفل بنجر السكر معنوياً عن التي استُبدل فيها حبوب الذرة بتفل بنجر السكر (٦٦,٣٦ مقابل ٦٥,٩٧٪). كذلك تأثرت قيم الـ TDN وDE معنوياً بإحلال تفل بنجر السكر محل الدريس/حبوب الذرة والتداخل بين الإحلال والنسب التجريبية.