

EFFECT OF RATIONS INCLUSION GUAVA BY-PRODUCTS WITH OR WITHOUT PROBIOTIC ON GROWTH PERFORMANCE OF GROWING GOAT KIDS

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SUMMARY

This study aimed to determine the effect of guava by-product (GBP) substitution at level 20% of concentrate feed mixtures with or without commercial probiotic (Enviva[®]PRO) on the performance of growing goat kids. Twenty-four growing Zaraibi male kids weighted 15 kg body weight in average and 7 months old; assigned to three groups (8 in each). Feeding trial lasted for 90 days. Animals were fed clover hay plus CFM (R1), CFM including 20% GBP (R2) or supplemented with probiotic, 5g/h/day (R3). Results showed insignificant differences in most nutrients and fiber fractions digestibilities and TDN values among treatments. Ruminant pH and TVFAs values did not differ significantly among treatments. While, ruminal NH₃-N concentrations were significantly ($p < 0.05$) higher with R2 and R3 compared to R1. Results indicated that neither GBP nor probiotic had an adverse impact on goats health which all blood parameters were within the normal range. There were no significant differences among treatments in total and average daily gain. Both R2 and R3 had lower total DM and TDN intake compared to R1. Meanwhile R3 group had the best feed conversion and the highest economical efficiency. It could be concluded that guava by-product (GBP) at level 20% of CFM and probiotic supplementation (5g/h/d) in growing kids goats rations had no adverse effects on productive performance with enhancing in economical efficiency.

Keywords: *guava by-product, probiotic, goat kids, performance.*

INTRODUCTION

The high cost and scarcity of conventional feed ingredients constitute major problems facing commercial production of ruminants in the developing countries of the world. In order to compensate the feed shortage and to reduce feeding cost attempts have been made to use agricultural and food industrial by-products as feed ingredients (Karkoodi *et al.*, 2012). In Egypt the quantity of agro-industrial by-products produced is relatively large most of these by-products are dumped or burned causing environmental pollution and consequently health hazards. The agro industrial by-products are less fibrous, more concentrated, highly nutritious and less costly as compared to crop residues (Aguilera, 1989). On the other side, they have a high moisture content so drying processes are needed.

Guava by-products (GBP; pulp, peel, seeds and inedible fruits) is produced as a waste of canning industry and yet was not fully evaluated as a feedstuff for animal. Lipids content of guava seeds was found to range from 8.9 to 9.4% (Opote, 1978 and Aly, 1981). The protein content of guava seeds was 9.73% on DM basis and the major amino acids constituted about 67% of the total amino acids (Adsule and Kadam, 1995). The GBP is a rich source of vitamin C 200-300 mg/100 g (Holland *et al.*, 1991). The pulp and peel fractions of guava had high content of fiber (48.55-49.42%) and extractable polyphenols (2.62-7.79%) methoxylated pectin, which can be a suitable source of natural antioxidants (Marquina *et al.*, 2008). The metabolizable Energy value of sun dried GBP was 2200 kcal/kg (El-Deek, *et al.*, 2009). Marquina *et al.* (2008) indicated that guava by-product could be used in Broiler and Finishing Diets. Also, El-Deek, *et al.* (2009) found that sun dried GBP could be included at a level of 15% in laying hen diets without adverse effect on productive performance and egg quality traits.

Maximization fiber utility of GBP could be achieved by different approaches such as probiotics addition that improve nutrient digestibility (Abd El-Ghani, 2004) reduce other pathogenic micro-

organisms by competing for the provision of nutrients and other growth factors (Rolfe, 2000). They are also known to increase ruminal pH (Mohamed *et al.*, 2009 and Paryad and Rashidi, 2009), total volatile fatty acids (VFA's) and ruminal biomass (Newbold *et al.*, 1996) and thus influence the cellulolytic activity and microbial protein synthesis and fiber degradation (Martin and Nisbet, 1990 and Yoon and Stern, 1996). Meanwhile, many studies recorded a positive effect of probiotics supplementation on nutrients intake, body weight gain and feed conversion ratio (FCR) in ruminants (Chiofalo *et al.*, 2004 and Whitley *et al.*, 2009).

The objective of this study was to evaluate the effect of using 20% GBP at level of 20% of concentrate feed mixture (CFM) in goats ration either with or without probiotic on performance, digestibility, feeding value, rumen liquor, some blood parameters. Meanwhile, on economic study was hold.

MATERIALS AND METHODS

Experimental animals and ration:

Twenty four Zaraibi kids averaged (15 kg) body weight; 7 months old were divided into 3 groups of 8 animals according to their live weight. Animal groups were as follows:- R1 (control ration): clover hay plus concentrate feed mixture (CFM), R2: clover hay plus CFM substituted with 20% guava by-products (GBP) and R3: clover hay plus CFM substituted with 20% guava by-products (GBP) and supplemented 5 g/h/d probiotic (Enviva[®]PRO). Roughage concentrate ratio was 30:70. The probiotic (Enviva[®]PRO) was daily mixed manually with CFM. The probiotic is a blend of three species of *Bacillus subtilis* and its by-products. The concentrate feed mixtures are presented in Table (1). The experiment lasted 90 days.

Table (1): Formulation of the experimental concentrate feed mixtures (CFM %).

Feed ingredients, %	Control	GBP
yellow corn	65	51
wheat bran	15	12
soybean meal	15	12
GBP*	-	20
Premix	1.2	1.2
common salt	0.8	0.8
Limestone	3	3

*GBP: Guava by-products

Feeding procedures:

The growing kids were fed CFM and clover hay twice daily to cover their total requirements according to NRC (1981). Water was allowed freely all the day round. Orts were collected just before offering the next day feed. Kids were weighed every two weeks before morning feeding after 15 h of fasting. Rations were adjusted every two weeks according to body weight changes (Khatab *et al.*, 2011). Body weight gain was recorded and daily feed intake was calculated. Dry matter, total digestible nutrients (TDN) and digestible crude protein (DCP) intake were calculated. Feed conversion ratio was calculated as follow (intake g/daily gain g) for DM and TDN.

Digestion trials:

After 90 days, three kids from each group were used in digestion trials to evaluate the experimental rations. In these trials the experimental rations consisted of 70 % CFM and 30% clover hay. Each trial was divided into two stages: a preliminary 21-day period to allow the animals to adapt to each feed, and a 7-day experimental period during which voluntary feed intake was measured and total collection of feces.

Sampling and analytical procedures:

Chemical analysis:

Feeds and feces were analyzed for proximate analyses (A.O.A.C., 2000). Nitrogen free extract was calculated by difference. The NDF and ADF were determined according to Van Soest *et al.* (1991). Cellulose and hemi-cellulose were calculated by difference according to the following equations: cellulose = ADF - ADL and hemi-cellulose = NDF – ADF.

Rumen liquor sampling:

Rumen liquor samples were taken just before morning feeding, three and six hours post feeding during collection period of digestion trials. Samples of rumen liquor were strained through two layers of cheesecloth and its pH was immediately measured after collection by using pH meter. Strained rumen liquor (SRL) samples were acidified with 0.1 N hydrochloric acid and concentrated orthophosphoric acid and stored by freezing for determination of total volatile fatty acids (TVFA's). Ammonia was determined according to (Preston, 1995). Total VFA was determined by steam distillation according to Cunniff (1997).

Blood parameters:

Blood samples were withdrawn from all the experimental animals. The blood samples were taken from the jugular vein in dry clean glasses tubes using heparin as anticoagulant and then centrifuged for 15 minutes at 4000 rpm to obtain plasma. Blood plasma total protein and creatinine were determined according to Tietz (1986) and Tietz *et al.* (1990), albumin was determined according to Doumas *et al.* (1971), blood plasma urea was determined according to Patton and Grouch (1977). Alanin amino transferase (ALT) and activity of aspartate transferease (AST) were determined by the methods of Young (1997).

Statistical analysis:

Data were analyzed using the general linear model procedure of SAS (2001, Ver.8.02, SAS Institute Inc., Cary, NC, USA). The differences among means were separated according to Duncan New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition and fiber fractions:

Results of chemical composition and fiber fractions of clover hay, concentrate feed mixture, guava by-product and experimental rations are shown in Table (2). Data of chemical composition indicated that GBP had low CP content (5.21%) and high CF (61.44%) and fiber fractions (75.77% NDF and 59.62% ADF) contents. El-Deek *et al.* (2009) recorded higher CP and lower CF contents of GBP being 9.08 and 39.50%, respectively. This may be due to the nature of guava by products. The previous observations explained lower CP and higher contents of CF and fiber fractions in rations contained GBP compared with control ration.

Table (2): Chemical composition of the experimental clover hay, concentrate feed mixture, guava by-products and the experimental rations

Item	Feedstuffs			Experimental rations	
	CFM	CH	GBP	Control	GBP20
DM	91.09	93.05	93.12	9.61	92.01
Chemical composition, % (DM basis)					
OM	94.10	92.69	97.26	93.73	94.11
Ash	5.90	7.31	2.74	6.27	5.89
CP	13.59	15.99	5.21	14.23	13.15
EE	6.02	1.55	4.69	4.83	4.49
CF	6.39	38.73	61.44	15.14	24.04
NFE	68.10	36.42	25.92	59.53	52.43
Fiber fraction, %					
NDF	19.23	49.83	75.77	27.35	36.37
ADF	8.98	42.97	59.62	18.00	26.32
ADL	2.66	9.41	25.06	4.45	7.83
Cellulose	6.32	33.56	34.56	13.55	18.49
Hemi-cellulose	10.25	6.86	16.15	9.35	10.05

CFM: Concentrate feed mixture, CH: Clover hay, GBP: Guava by-products, Control: clover hay plus CFM and GBP20: clover hay plus CFM substituted with 20% GBP. 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.

Nutrients digestibility and nutritive values:

Nutrients digestibility and nutritive values of the experimental rations are presented in Table (3). In general, no significant differences in most nutrients and fiber fractions digestibilities and nutritive value as TDN were observed among treatments. While, rations containing GBP either with or without probiotic (R2 and R3) recorded higher digestibility of NFE and lower nutritive value as DCP than control.

Table (3): Nutrients digestibility and nutritive values of the experimental rations

Item	Experimental rations			±SE
	R1	R2	R3	
Apparent digestibility, %				
DM	77.09	73.56	75.85	0.77
OM	77.91	74.95	77.08	0.70
CP	73.75	71.75	73.94	0.71
CF	60.74	55.47	58.31	1.23
EE	84.16	85.63	86.12	0.44
NFE	72.76 ^b	73.76 ^{ab}	75.70 ^a	0.56
Fiber fractions:				
NDF	57.41	52.48	54.34	1.27
ADF	58.25	53.03	57.11	1.29
Cellulose	66.37	64.33	66.13	0.85
Hemi-cellulose	55.79	51.02	49.10	1.49
Nutritive values, %				
TDN	72.15	70.10	72.13	0.63
DCP	10.49a	9.43b	9.74b	0.18

^{a, b, ...} Means in the same row with different superscript are significantly different (P<0.05). TDN: Total digestible nutrients and DCP: Digestible crude protein.

R1: Control ration (Concentrate feed mixture + Clover hay).

R2: clover hay plus CFM substituted with 20% GBP.

R3: clover hay plus CFM substituted with 20% and supplemented with 5g/h/d probiotic.

Results showed that including GBP in goats ration (R2) decreased digestibilities (P>0.05) of DM, OM, CP, CF, fiber fractions and TDN insignificantly decreased DCP. These results are matched with chemical composition of the experimental rations.

It is clear that probiotic supplementation to ration (R3) insignificantly (P>0.05) improved the digestibilities of most nutrients and fiber fractions and nutritive values as TDN and DCP compared to R2. In this connection, Ali (2005), Gaafar *et al.* (2005) and Kholif and Khorshed (2006) recorded an increase in CP and CF digestibilities with probiotic supplementation. Whitley *et al.* (2009) also reported an improvement in apparent digestibilities of DM, CP, NDF and ADF in goats fed diet supplemented with commercial probiotics. However, Titi *et al.* (2008) reported that addition of probiotics (yeast culture) had no effect on digestibility of DM, CP and NDF. These results might be due to the positive effect of probiotic supplementation on cellulolytic activity by increasing numbers of ruminal fibrolytic microbes and rumen microbial protein synthesis (Martin and Nisbet, 1990, Yoon and Stern, 1996, Nsereko *et al.*, 2002 and Tricarico *et al.*, 2005).

Rumen liquor parameters:

Results concerning the effect of experimental rations and sampling time on rumen liquor parameters are shown in Table (4). Inclusion of GBP in rations either with (R3) or without (R2) probiotic had no significant effects (p>0.05) on ruminal pH and TVFA's values compared with control (R1). The result concerning probiotic supplementation coincides with those obtained by Yoon and Stern (1996), Ali

(2005) and Abd El-Wahed (2007). However, Mohamed *et al.* (2009), Paryad and Rashidi (2009) and Khalid *et al.* (2011) observed an increase in ruminal pH value when probiotic was added.

On the other hand, ruminal NH₃-N concentrations were significantly higher ($p < 0.05$) in R2 and R3 compared to R1. The increase in ruminal NH₃-N with probiotic supplementation might have been associated with a stimulation of proteolytic activity of rumen bacteria (Oeztuerk, 2009). Yoon and Stern (1996) reported that the addition of 57 g/d, Diamond V XP yeast culture increased numbers of proteolytic bacteria. It has been suggested that the increasing in bacterial population is central to the action of the yeast (Newbold *et al.*, 1996). The most famous theory was suggested by Oeztuerk, 2009 that yeast culture provides various growth factors, pro-vitamins, and/or micronutrients and removes potentially harmful oxygen from the rumen environment.

Blood parameters:

Results of blood plasma total protein, globulin, total lipids, glucose, urea, creatinine and AST concentrations in Table (5) did not show any significant differences among rations. However, R2 showed significant difference ($p < 0.05$) with blood albumin, triglyceride and ALT concentrations compared with other rations.

Table (4): Effect of the experimental rations on rumen parameters of growing goat kids

Item	Sampling time, hrs.	Experimental rations			±SE
		R1	R2	R3	
pH	0	6.89	6.87	6.84	0.08
	3	5.98	5.91	5.69	0.19
	6	6.09	6.03	5.86	0.19
	Mean	6.32	6.27	6.13	0.12
NH ₃ -N, mg/100 ml rumen liquor	0	35.40 ^b	39.80 ^{ab}	42.60 ^a	1.47
	3	36.40 ^c	43.40 ^b	61.60 ^a	1.40
	6	53.20 ^c	60.20 ^b	67.50 ^a	1.63
	Mean	41.67 ^c	47.80 ^b	57.23 ^a	0.88
TVFA, mEq/100 ml rumen liquor	0	14.10	13.20	13.00	0.77
	3	15.90	18.00	17.80	0.92
	6	15.30	15.30	16.50	0.62
	Mean	15.10	15.50	15.77	0.35

^{a, b, c} Means in the same row with different superscript are significantly different ($P < 0.05$).

R1: Control ration (Concentrate feed mixture + Clover hay).

R2: clover hay plus CFM substituted with 20% GBP.

R3: clover hay plus CFM substituted with 20% supplemented with 5g/h/d probiotic.

Table (5): Effect of the experimental rations on blood plasma parameters of growing goat kids

Item	Experimental rations			±SE
	R1	R2	R3	
Total proteins, g/dl	5.58	5.36	5.70	0.29
Albumin, g/dl	3.88 ^b	4.21 ^{ab}	4.71 ^a	0.23
Globulin, g/dl	1.71	1.16	0.99	0.41
Triglyceride, mg/dl	1.19 ^{ab}	1.79 ^a	0.61 ^b	0.20
Total lipid, mg/dl	1138.21	1157.18	1146.34	63.36
Glucose, g/dl	66.35	59.31	49.29	5.44
Urea, mg/dl	28.63	18.53	12.94	5.10
Creatinine, mg/dl	0.97	1.01	1.06	0.03
AST, IU/L	57.82	74.02	66.39	10.50
ALT, IU/L	8.19 ^b	11.64 ^a	7.94 ^b	0.24

^{a, b} Means in the same row with different superscript are significantly different ($P < 0.05$). ALT: Alanin amino transferase and AST: Aspartate transferase

R1: Control ration (Concentrate feed mixture + Clover hay).

R2: clover hay plus CFM substituted with 20% GBP.

R3: clover hay plus CFM substituted with 20% and supplemented with 5g/h/d probiotic.

The blood urea and glucose concentrations were insignificantly the lowest with combination of GBP and probiotic (R3) compared to R1 and R2. However, Abo El-Nor and Kholif (1998) reported higher blood urea nitrogen values in response to probiotics supplementation. The lower blood plasma urea nitrogen with probiotics supplementation could be due to improved utilizing of N in the rumen (Bruno *et al.*, 2009). The lower blood glucose in R2 and R3 might be attributed to higher fiber digestion leading to more production of ketogenic moieties.

Generally, all blood plasma parameters were within the normal range mentioned by Merck (2014). Blood parameters regarding kidneys and liver functions had no adverse impact on animal health.

Growth performance:

No significant differences were noticed among treatments in final body weight, total body weight gain and average daily gain (Table 6). The GBP and probiotic (R3) insignificantly increased total and daily weight gain being 6.36 kg and 70.66 g/d, respectively compared to 5.50 kg and 61.10 g/d in R2, in the same order. This slight improvement in R3 compared to R2 may be a result of improving DM, OM, CF digestibilities and nutritive values as TDN and DCP when probiotic was added. Also, higher body weight gain with probiotic supplementation might be due to more cellulolytic activity resulting in improvement of fiber degradation (Russell and Wilson, 1996). Titi *et al.* (2008) reported that yeast supplementation had no effect on growth rate in lambs and kids. Baranowski *et al.* (2007) and Whitley *et al.* (2009) also found the same results with probiotic supplementation. While, Erasmus *et al.* (1992) and Haddad and Goussous (2005) found that probiotics supplementation tended to increase weight gain in lambs.

Table (6): Effect of the experimental rations on growth performance of growing goat kids and economical efficiency

Item	Experimental rations			±SE
	R1	R2	R3	
Live body weight:				
Initial body weight, kg	15.80	15.00	14.40	0.95
Final body weight, kg	22.68	20.50	20.76	1.05
Total weight gain, kg	6.88	5.50	6.36	0.39
Average daily gain, g	76.00	61.00	70.00	4.29
Feed intake/day:				
Concentrate, g	385 ^a	292 ^b	299 ^b	16.44
Roughage, g	250 ^a	220 ^b	219 ^b	5.57
Total DMI, g	635 ^a	512 ^b	518 ^b	16.34
TDN intake, g	458 ^a	359 ^b	374 ^b	21.05
Feed conversion, g/g:				
DMI/ daily gain	8.31 ^a	8.38 ^a	7.33 ^b	0.18
TDN intake / daily gain	6.04 ^a	5.87 ^{ab}	5.29 ^b	0.13
Economic efficiency				
Feeding cost, LE/h/d	1.40	1.23	1.17	----
Gain price, LE/h/d	2.75	2.20	2.54	----
Profit, LE/h/d	1.35	0.97	1.37	----
Relative (profit/feeding cost %)	0.96	0.76	1.17	----
Economic improvement	100	79.16	121.87	----

^{a, b,} Means in the same row with different superscript are significantly different ($P < 0.05$).

Prices (LE: Egyptian pound): concentrate feed mixture for R1 (2.55 LE/kg) and (2.00 LE/kg) for R2 and R3, clover hay (1.7 LE/kg), probiotic (40 LE/kg), live weight for kids (36 LE/kg).

R1: Control ration (Concentrate feed mixture + Clover hay).

R2: clover hay plus CFM substituted with 20% GBP.

R3: clover hay plus CFM substituted with 20% and supplemented with 5g/h/d probiotic.

Regarding feed intake, kids fed rations containing GBP (R2 or R3) had significantly ($p < 0.05$) lower intake of concentrate, roughage, total DM and TDN intakes compared with those fed control ration (R1). However, R3 was insignificantly higher than R2 in total intake of DM and TDN. The positive effect of

yeast supplementation on total DM and TDN intakes could be attributed to high nutrients and fiber fraction digestibility's and TDN value. Similarly, Chademana and Offer (1990), Chiofalo *et al.* (2004) and Desnoyers *et al.* (2009) reported a promoting role of probiotics on dry matter intake. However, Titi *et al.* (2008) observed no effect on DMI when diets of lambs and kids were supplemented with yeast culture. Likewise, Haddad and Goussous (2005) and Hernandez *et al.* (2009) reported similar findings.

Feed conversion ratios (FCR) as DM or TDN/daily gain were the best in R3 compared to R1 and R2. Probiotics have been reported to improve FCR in ruminants (Robinson, 2002, Haddad and Goussous 2005, Abdelrahman and Hunaiti, 2008, Mutassim and Hunaiti, 2008 and Jang *et al.* 2009). In contrast, Baranowski *et al.* (2007) observed no effect of probiotic supplementation on FCR.

Economical efficiency:

Data in Table (6) showed that ration containing GBP plus probiotic (R3) recorded the lowest feed cost (1.17 LE/h/d) and the highest economical efficiency either as profit (1.37 LE/h/d) or profit/feeding cost (1.17%) compared to R1 and R2. In the same trend, Ali (2005) observed an improvement in economical efficiency when lambs were fed ration containing corn stalks plus probiotic.

CONCLUSION

In view of the obtained results, it could be concluded that addition of commercial probiotic (5g/h/d) to GBP at a level of 20% in concentrate feed mixture can improve the performance of growing kids with high economical efficiency.

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تأثير العلائق المحتوية على مخلفات الجوافة مع أو بدون محفز النمو على أداء الجداء النامية

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تهدف هذه الدراسة إلى تحديد تأثير إحلال مخلفات الجوافة محل مخلوط العلف المركز بنسبة 20% مع أو بدون البروبيوتيك على أداء جداء الماعز النامية، استخدم عدد 24 جدى زريبي نامى (عمر سبعة أشهر و متوسط وزن 15 كجم) قسمت إلى ثلاثة مجاميع، ثمانية حيوانات فى المجموعة وأستمرت تجربة التغذية لمدة 90 يوم. تغذت الحيوانات على دريس البرسيم ومخلوط العلف المركز (المجموعة الأولى)، مخلوط علف مركز يحتوى على 20% مخلفات جوافة فقط (المجموعة الثانية)أو مع 5 جم محفز نمو/رأس / يوم (المجموعة الثالثة). أظهرت النتائج عدم وجود فروق معنوية بين المعاملات فى هضم معظم العناصر الغذائية وتحليلات الألياف والمركبات الكلية المهضومة. لم تختلف قيم درجة حموضة الكرش والأحماض الدهنية الطيارة الكلية بين المعاملات. فى حين كان تركيز الأمونيا فى الكرش مرتفعاً بشكل معنوى فى المعاملة الثانية والثالثة مقارنة بالمعاملة الأولى. أشارت النتائج أن كل من مخلفات الجوافة أو البروبيوتيك لم يكن لها تأثير معنوى على صحة الماعز حيث كانت مقاييس الدم فى المدى الطبيعى. لم يكن هناك أى اختلافات بين المعاملات فى الزيادة الكلية فى الوزن ومعدل النمو اليومي. المعاملة الثانية والثالثة كانت أقل فى قيم المأكول من المادة الجافة والمركبات الكلية المهضومة مقارنة بالمعاملة الأولى، فى حين أعطت المعاملة الثالثة أفضل معدل تحويل غذائى وأفضل كفاءة اقتصادية. مما سبق يتضح أنه يمكن استخدام مخلفات الجوافة عند مستوى 20% من مخلوط العلف المركز مع إضافة البروبيوتيك بمعدل 5 جم/رأس/يوم فى علائق جداء الماعز النامية بدون أى تأثيرات سلبية على الأداء الإنتاجى مع تحسن فى الكفاءة الاقتصادية.