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The Nutritional Evaluation of Locally Produced Dried Bakery Waste (DBW) in the Broiler Diets

Abdullatif A. Al-Tulaihan[1], Huthail Najib[2] and Salah M. Al-Eid[2]
[1]Agriculture Research Center, Ministry of Agriculture, P.O. Box 43, Hoffuf 31982, Kingdom of Saudi Arabia
[2]King Faisal University, College of Agricultural Sciences and Food,
P.O. Box 420, Hofuf 31982, Kingdom of Saudi Arabia

Abstract: Due to the harsh environment of Saudi Arabia, yellow corn and soybean, the main energy and protein sources of the poultry diet are not successfully grown in this area. Therefore search for a locally produced alternative is of utmost important. Early studies suggested that bakery products could be considered as energy substitute. Tons of dried bakery waste (DBW) are produced in the local bakeries of Saudi Arabia. This experiment was conducted to evaluate the use of dried bakery waste in the diets of broilers. Five levels of DBW: 0 , 5, 10, 20 and 30% were fed to 250 broiler chicks. These diets were iso-caloric iso-nitrogenous containing 3200 kcal/kg metabolizable energy (ME) with 22% crude protein in the starter diet and 20% protein and 3200 kcal/kg ME in the finisher diet. The results provided evidence that inclusion of up to 30% DBW in the broiler diets had no harm effect on the performance of the birds. It was concluded that DBW, obtained from local bakeries can replace part of the corn in the broiler diets without negatively affecting the performance.

Key words: Dried bakery waste, broilers, poultry diet, corn

Introduction

Corn is the major source of energy in the poultry rations. This crop is not grown widely in the Middle East area, therefore, large amount of this grain is imported from different countries which would add extra cost to the already expensive poultry ration. Saudi Arabia imports tons of corn yearly (Watt Poultry Statistical Book, 1999). Therefore, it is very important for the economy of this country to find a locally produced ingredient that can replace part of the corn without negatively affecting performance of the birds. Scientists in this area have long been trying to find an efficient replacement to corn. So far success was limited due to either bad performance or the high cost of the new ingredient (date was used by Najib *et al.,* 1994 and Salicornia, by Al-Batshan *et al*., 2001).

Many years ago bakery by-product was used in the west, however, its' use was limited due to its' high content of fat and salt. Saudi bakeries produce only Arabic bread and samoly which are known for lower fat and salt content. Early in 1965, Damron and others provided evidence that dried bakery product can be included in broiler diets without adversely affecting their performance. Patrick and Schaible (1980) reported that bakery products might be used to replace part of the grain fed to poultry as energy source.

Recent studies on the inclusion of DBW in the poultry diet are rare, however, its chemical composition has been determined. Waldroup *et al*. (1982) reported that the fat content of the samples varies from 5.3 to 14.4%. It is assumed that fat content of DBW of Saudi Arabia is in the lower range, since not much sweet products are made in the bakeries. Similarly, Thomas *et al*. (1981) observed high variation in the nutrient content of DBW samples produced at different plans and salt content of the samples ranged from 1.8 to 3.4%.

DBW of Saudi Arabia is a mixture of different types of bread produced by the bakerage industry, including Arabic bread, American bread, Samoly and small amounts of cakes and cookies. Amounts of these products may vary from place to place; however, it is noticed that large quantities are being thrown away yearly. If some of these amounts can be utilized as energy substitute for corn in the poultry ration, it may benefit the producer and the poultry industry.

The objectives of this study were to determine the chemical composition of the Saudi DBW and the possibility of using different levels of this product in the broilers diet.

Materials and Methods

Two and half tons of dried bakery by-products (DBP) were obtained from ten local commercial bakeries in AL-Hassa area of Saudi Arabia. They comprised of Arabic bread, Samoli and Frankfurter buns. Dirt and debris were removed manually. The resulting by-products were collected and partially dried to keep the moisture content to about 8%. This by-product was then ground (particle size 6mm) using Europe mill machine (DK 8721, DAYARD of Denmark). Two methods of drying the DBW were considered; namely, using a machine, which depends on the solar energy, and other using natural drying in the outside. Since the first method takes longer time, needs larger space and cost more,

Table 1: The dietary treatments of broiler (starter) experiment

Ingredients %	DBW, %				
	0	5	10	20	30
Corn	62.00	55.69	51.16	43.50	34.57
SBM	24.5	28.38	28.38	28.00	29.30
Fish meal	6.50	3.70	3.39	2.78	1.25
Dical. Phos.	1.00	0.90	0.90	0.90	1.00
Limestone	1.54	1.59	1.67	1.67	1.70
Vit. & min.[1]	0.20	0.20	0.20	0.20	0.20
Salt	0.40	0.40	0.40	0.40	0.40
DL Meth.	0.028	0.23	0.23	0.25	0.10
Fat	3.83	3.95	3.54	2.26	1.35
DBW	0.00	5.00	10.00	20.00	30.00
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition					
Metabolizable E. (ME), Kcal/Kg	3200	3200	3200	3200	3200
Protein, %	22	22	22	22	22
Ca, %	1.03	0.98	1.01	1.01	1.02
TP, %	0.64	0.6	0.61	0.62	0.65
Methionine, %	0.44	0.6	0.6	0.6	0.43
Cystine, %	0.33	0.33	0.32	0.3	0.28
Lysine, %	1.24	1.20	1.19	1.16	1.12
Choline, mg/kg	1398	1300	1281	1185	1089
Linoleic acid, %	1.47	1.34	1.24	1.07	0.88

[1]This mixture provided the following per kilogram of diet: Vit A, 10000IU; Vit D_3, 5500 ICU; Vit E, 8 mg; Choline, 20 mg; Vit B_1, 1.5 mg, Vit B_2, 4 mg; Vit B_6, 0.8 mg; Niacin, 20 mg; PA, 8 mg; Folic Acid, 0.8 mg; Biotin, 0.08 mg; Vit C, 80 mg; Ethoxyquin, 56 mg; Cu, 12 mg; I, 0.9 mg; Fe, 80 mg; Mn, 80 mg; Zn, 48 mg; Co, 0,04 mg; Se, 0.16 mg.

Table 2: The dietary treatments of Broiler (Finisher) experiment Ingredients, %

	DBW, %				
	0	5	10	20	30
Corn	65.21	61.50	57.00	48.55	40.50
SBM	24.00	24.50	25.03	25.40	24.20
Fish meal	3.60	2.90	2.18	1.27	1.23
Dical. Phos.	1.22	0.70	0.70	0.70	0.70
Limestone	1.54	1.62	1.72	1.80	1.70
Vit. and min.[1]	0.20	0.20	0.20	0.20	0.20
Salt	0.40	0.40	0.40	0.40	0.40
DL Meth.	0.03	0.13	0.13	0.15	0.17
Fat	3.80	3.05	2.64	1.57	0.47
DBW	0.00	5.00	10.00	20.00	30.00
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition					
Metabolizable E. (ME) Kcal/Kg	3200	3200	3200	3200	3200
Protein, %	20.00	20.03	20.00	20.05	20.00
Ca, %	1.01	0.92	0.95	0.97	0.94
TP, %	0.63	0.54	0.55	0.56	0.58
Methionine, %	0.38	0.47	0.46	0.47	0.48
Cystine, %	0.32	0.31	0.3	0.28	0.26
Lysine, %	1.08	1.06	1.04	1.01	1.06
Choline, mg/kg	1251	1204	1153	1062	1000
Linoleic acid, %	1.53	1.45	1.36	1.17	0.99

[1]This mixture provided the following per kilogram of diet: Vit A, 10000 IU; Vit D3, 5500 ICU; Vit E, 8 mg; Choline, 20 mg; Vit B_1, 1.5 mg, Vit B_2, 4 mg; Vit B_6, 0.8 mg; Niacin, 20 mg; PA, 8 mg; Folic Acid, 0.8 mg; Biotin, 0.08 mg; Vit C, 80 mg; Ethoxyquin, 56 mg; Cu, 12 mg; I, 0.9 mg; Fe, 80 mg; Mn, 80 mg; Zn, 48 mg; Co, 0,04 mg; Se, 0.16 mg.

Table 3: Analysis of dried bakery by-product

Nutrient	This study %	Dale (1990) %	Saleh (1996) %
By Analysis			
Moisture, %	8.43	10.2	8.11
Crude protein,%	12.22	10.6	12.53
Ether extract,%	1.32	11.1	11.04
Crude fiber, %	0.18	2.5	2.25
Ash, %	1.83	4.8	4.48
Calcium, %	0.18	-	0.28
Phosphorus, %	0.15	-	0.52
Sodium, %	3.2	-	0.93
Potassium, %	0.45	-	-
Magnesium, %	0.08	-	-
Chloride, %	0.12	-	1.37
TMEn, kcal/kg[1]	3895.4	3630[2]	3670

[1]Calculated from the following Equation. TMEn (Kcal/g) = 4.34-0.10 (% CF)-0.04 (% Ash)-0.03(% CP)+0.01(%EE)
[2]TMEn Range = 3050-3980 Kcal/Kg

Table 4: The amino acid contents of the Dried Bakery Waste (DBW)

Amino acids	Results (%)
ASPARTIC ACID	0.56
THREONINE	0.38
SERINE	0.64
GLUTAMIC ACID	4.58
GLYCINE	0.54
ALANINE	0.67
VALINE	0.56
METHIONINE	0.28
ISOLEUCINE	0.42
LEUCINE	0.87
TRYOSINE	0.31
PHENYLALANINE	0.61
HISTIDINE	0.31
LYSINE	0.27
ARGININE	0.48

Bold = essential amino acids

therefore, the second method was preferred and used. Samples from the mixture were subjected to analysis for determination of nutrients, using the methods of American Association of cereal chemists (AACC, 1994). Moisture content was determined according to (AACC, 44-16) using (Memmert 854 Schwabach drying oven), Ash content was determined according to (AACC, 08-01) using (Agallenkamp muffle furnace; England). Crude protein (CP) was determined according to AACC, 46-10) using Kjeltec auto 1030 analyzer). Ether extract (EE) was determined according to (AACC, 30-25) using (Soxhlet, HT2 1045 Extraction Unit), and Crude Fiber (CF) was determined according to (AACC, 32-10) using (Lab. Conco, Corporation Kansas City, Missouri 64132).

True Metabolizable energy (TME) content of the by-product was estimated based on the equation developed by Dale *et al*. (1990). This equation is stated as follow:

TME_n(kcal/kg)= 4,340-100xCF-40xAsh-30xCP+10xEE.

Macro minerals such as ; Fe, Na, Cl, K, and Mg were determined using Atomic absorption Spectrophotometry method as described in (AACC, 70-21)) (Pxe Unicam Ltd, York street, Cambridge, England. CB1, . 2PX. Gt. Britain). Phosphorus (P) was determined using the Vanadomolybdate calorimetric method.

Amino acids were determined using High Performance Liquid Chromatography (HPLC) method as described in AOAC (1984).(model 1993, Shimadzu, Japan).

Aflatoxin was determined in the Dried Bakery Waste (DBW) by using TLC method according to Samuel (1978).

Chicks and housing: Two hundred fifty, day-old hybro broilers were purchased from a local hatchery. They were randomly distributed, intermingled in 25 cages, each containing 10 chicks. Birds were weighed individually every week and weight gain was determined. Feed was added, as necessary, and weekly and cumulative feed intakes were determined from feed left as opposed to feed given. Weekly mortality was calculated based on number of birds, died in a specific day of the week. Four birds, two males and two females, were slaughtered for dressing analysis.

During the 49 days of the broiler experiment, birds were housed in two types of cages, one especially made for chicks up to four weeks old and equipped with heaters and other larger one, to house the birds as they grow older. Both cages were equipped with manual feeders and waterers. They were allocated in a room with cooling devices. During the first week, temperature was set at 32 ^{o}C, and then reduced by 3 ^{o}C weekly until it reached 24 ^{o}C, which remained as such to the end of the experiment. The chicks were moved to the grower cages at the beginning of week 5.

A certain program was used to vaccinate the broiler chicks against the most prevailing diseases in this area during the first 28 days of their life.

Feeds and feeding: Five levels of DBW replaced the corn in the ration at the rate of 0, 5, 10, 20 and 30%. These dietary treatments were assigned to the cages in such a way that each dietary treatment was assigned to five battery pens (replications). Tables 1 and 2 present the dietary treatments and the calculated composition of the diets that were fed to the birds from day 1 to 4 weeks (starter diet) and from week 5 to the end of the experiment (finisher diet). This study lasted 49 days.

Statistical analysis: A completely randomized design

Table 5: Effect of DBW inclusion on weekly performance of broilers, raised in cages

Performance	TRT	Week						
		1	2	3	4	5	6	7
Weekly feed intake (gm)	0	154.0^{a}	365.2^{a}	490.0^{a}	682.4^{a}	761.8^{ba}	1019.6^{a}	899.6^{a}
	5	125.2^{b}	356.0^{a}	495.2^{a}	641.2^{ba}	718.2^{b}	944.8^{ba}	929.4^{a}
	10	82.2^{c}	279.4^{b}	442.4^{a}	610.0^{b}	771.0^{ba}	886.2^{b}	834.0^{a}
	20	119.0^{b}	336.2^{ba}	443.6^{a}	634.8^{ba}	813.8^{a}	870.4^{b}	818.0^{a}
	30	116.8^{b}	349.8^{a}	464.6^{a}	645.2^{ba}	753.2^{ba}	940.8^{ba}	892.8^{a}
	P =	0.0001	0.0576	0.1734	0.1126	0.1971	0.0087	0.1660
Weekly feed conversion, Kg feed/kg gain	0	1.387^{a}	1.711^{a}	1.379^{a}	2.519^{a}	2.872^{a}	2.223^{a}	2.941^{a}
	5	1.273^{a}	1.914^{a}	1.422^{a}	2.501^{a}	2.300^{ba}	2.080	3.011^{a}
	10	0.773^{b}	1.785^{a}	1.349^{a}	2.656^{a}	2.375^{ba}	2.082^{a}	3.039^{a}
	20	1.230^{a}	1.979^{a}	1.414^{a}	2.532^{a}	2.709^{ba}	2.127^{a}	2.667^{a}
	30	1.240^{a}	2.017^{a}	1.355^{a}	2.418^{a}	2.249^{b}	2.153^{a}	2.958^{a}
	P =	0.0001	0.3035	0.8938	0.3849	0.0985	0.7635	0.9056
Weekly livability (%)	0	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}	99.7^{a}	99.7^{a}
	5	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{a}	100.0^{a}	97.4^{a}
	10	100.0^{c}	100.0^{c}	100.0^{c}	100.0^{c}	98.4^{ba}	100.0^{a}	96.7^{a}
	20	100.0^{d}	100.0^{d}	100.0^{d}	100.0^{d}	94.6^{b}	97.78^{a}	95.2^{a}
	30	100.0^{e}	100.0^{e}	100.0^{e}	100.0^{e}	99.1^{a}	100.0^{a}	96.8^{a}
	P =	0.0001	0.0001	0.0001	0.0001	0.0531	0.4665	0.5290
Weekly gain (gm)	0	111.2^{a}	213.9^{a}	355.9^{a}	270.8^{a}	276.0^{b}	458.5^{a}	306.9^{a}
	5	98.3b^{c}	186.6^{b}	348.7^{a}	258.0^{a}	317.6^{ba}	455.2^{ba}	313.2^{a}
	10	107.1^{ba}	156.6^{c}	329.3^{ba}	230.6^{b}	327.5^{ba}	425.8^{ba}	286.9^{a}
	20	97.1^{bc}	169.5^{cb}	313.7^{b}	251.0b^{a}	301.3^{ba}	412.3^{b}	319.0^{a}
	30	94.6^{c}	173.7^{cb}	343.9^{a}	267.2^{a}	335.7^{a}	440.6^{ba}	327.5^{a}
	P =	0.0139	0.0001	0.0161	0.0128	0.1611	0.1456	0.9118

Means that are not followed by the same letters are significantly different at p<0.05. TRT = 0, 5, 10, 20 % and 30% DBW

Table 6: Effect of DBW inclusion on cumulative performance of Broilers, raised in cages[1]

Performance	TRT	Week						
	TRT	1	2	3	4	5	6	7
Cumulative feed consumption (gm)	0	154.0^{a}	519.2^{a}	1009.2^{a}	1691.6^{a}	2453.4^{a}	3473.0^{a}	4372.6^{a}
	5	125.0^{b}	481.2^{a}	976.4^{ba}	1617.6^{ba}	2335.8^{ba}	3280.6^{b}	4210.0^{ba}
	10	82.2^{c}	361.6^{b}	804.0^{c}	1414.0^{c}	2185.0^{b}	3071.2^{c}	3905.2^{c}
	20	119.0^{b}	455.2^{a}	898.8^{b}	1533.6^{bc}	2347.4^{ba}	3217.8^{cb}	4035.6^{bc}
	30	116.8^{b}	466.6^{a}	931.2^{ba}	1576.4^{ba}	2329.6^{ba}	3270.4^{b}	4163.2^{ba}
	P =	0.0001	0.0011	0.0012	0.0018	0.0271	0.0032	0.0021
Cumulative body weight (gm)	0	155.1^{a}	369.1^{a}	725.0^{a}	995.8^{a}	1271.8^{a}	1730.3^{a}	2037.2^{a}
	5	141.3^{bc}	327.9^{b}	676.6^{b}	934.6^{b}	1252.2^{bac}	1707.4^{a}	2020.5^{a}
	10	149.9^{ba}	306.5^{b}	635.8^{c}	866.4^{c}	1193.9^{bc}	1619.7^{b}	1906.6^{b}
	20	141.6^{bc}	311.1^{b}	624.8^{c}	875.8^{c}	1177.1^{c}	1589.4^{b}	1908.4^{b}
	30	137.7^{c}	311.44^{b}	655.4^{cb}	922.6^{b}	1258.3^{ba}	1698.9^{a}	2026.4^{a}
	P =	0.0095	0.0001	0.0001	0.0001	0.0432	0.0020	0.0001
Cumulative feed conversion kg feed/kg live weight	0	0.993^{a}	1.408^{a}	1.393^{ba}	1.700^{a}	1.931b^{a}	2.008^{a}	2.146^{a}
	5	0.885^{b}	1.469^{a}	1.444^{a}	1.731^{a}	1.869b^{a}	1.923^{a}	2.084^{a}
	10	0.550^{c}	1.181^{b}	1.264^{b}	1.632^{a}	1.830^{b}	1.896^{a}	2.048^{a}
	20	0.841^{b}	1.460^{a}	1.439^{a}	1.751^{a}	1.995^{a}	2.026^{a}	2.115^{a}
	30	0.849^{b}	1.497^{a}	1.424^{a}	1.710^{a}	1.854^{ba}	1.928^{a}	2.055^{a}
	P =	0.0001	0.0118	0.0769	0.2939	0.1047	0.1768	0.2313

[1]Means that are not followed by the same superscript are significantly different P< 0.05. TRT = 0%, 5%, 10%, 20% and 30% DBW

Table 7: The effect of DBW levels on dressing parameters of broiler[1]

Level of DBW, %		BW, g	DW, g	D, %
TRT x Sex		NS	NS	NS
0	F	1876	1530	81.54
0	M	2228	1798	80.71
5	F	1966	1612	82.14
5	M	2252	1834	81.38
10	F	1848	1578	85.22
10	M	2292	1880	81.95
20	F	1858	1536	82.56
20	M	2054	1590	77.21
30	F	1918	1572	81.89
30	M	2276	1840	80.85
P =		0.653	0.8248	0.1522
Among TRT		NS	NS	*
0		2052[a]	1664[a]	81.13[b]
5		2109[a]	1723[a]	81.76[ab]
10		2070[a]	1729[a]	83.59[a]
20		1956[a]	1563[a]	79.88[b]
30		2097[a]	1706[a]	81.37[ab]
P =		0.3876	0.1998	0.0255
Between sex		**	**	**
F		1893.2[b]	1565.6[b]	82.67[b]
M		2220.4[a]	1788.4[a]	80.42[a]
P =		0.0001	0.0001	0.0020

[1]Means that Are not followed by the same superscript are significantly different, P< 0.05. levels of DBW in the broiler ration 0, 5, 10, 20 and 30% BW: Llive body weight, g, DW: Dressed weight, gm. D: Dressing, %

(Steel and Toorie, 1980) was adopted to execute this experiment, using the GLM procedure of SAS (SAS, 1988). Means showing significant differences in the ANOVA table were compared using the Duncan Multiple Range Test (Steel and Toorie, 1980).

Results and Discussion

The result of the chemical analysis of the Dried Bakery Waste is presented in Table 3. This table also showed the analysis of Dale (1990) and Saleh (1996). It was obvious that dried bakery waste, observed from the local bakeries of Saudi Arabia, was in close proximity, in some aspects, to those reported by Dale (1990) and Saleh (1996), Such as protein and moisture contents. However, ether extract value was varied considerably from the values of the above authors. This could be due to fact that majority of the products in the Saudi bakeries are breads of different kinds which are usually low in fats. Therefore, the high energy of the Saudi by-products reported herein was mainly observed from carbohydrates. Ash content is much lower than that reported by other authors who also contributed to the lower calcium and phosphorus, found in the samples. It is also noteworthy that crude fiber content of these samples were lower than those reported by other authors which probably indicate that whole wheat is not used heavily in making bread in this country.

The result of the Amino Acids determination is presented in table 4. It is clear from the values that DBW is not rich in methionine, the sulfur containing amino acid, and in lysine. However, methionine value was much higher in the DBW (0.281 %) comparing to that of the yellow corn.

Data of the weekly traits showed an inconsistent response to the levels of DBW (Table 5). While, weekly gain with 0% DBW was the highest in weeks; 1, 2, 3, 4 and 6, it was the highest in week 7 when 30% was incorporated in the diet (Table 5). This result was reflected on the feed conversion value. Although, the differences were not significant, P>0.05, The best feed conversion (2.667 kg feed/kg gain) was obtained in week 7 when the birds were fed 30% DBW.

With the exception of week 5, the highest feed intake was achieved in birds fed 0.0 or 5.0% DBW. Another study in this Institute showed that layers had no problem with palatability of the diets, fortified with DBW. It is worth to note that older birds were able to overcome the palatability problem since no significant differences were obtained in week 7.

Regardless of treatments, weekly percent increases in weight were consistent during the weeks of the experiment. The highest increase was in week 1 (about 70 %). A gradual decrease followed in the weeks 2 to 7. Weekly percent increase in weight is another way of looking at weight gain. Most of the mortality occurred in weeks 5, 6 and 7. The highest mortality, which included all the treatments, occurred in week 7. This mortality could be attributed to the decrease in space allowances in the cage, as the birds get bigger.

Cumulative performance of the broilers showed a better way of how the birds were responding to the treatments (Table 6). The best representation of the performance was in week 7. It is clear from Table 6 that the differences between the control group (0.0 % DBW) and those fed 5 % and 30 % pertaining to body weight were not significant (P>0.05). Similarly, the differences in feed consumption were not significant between the control group and those fed 5 %, 20 %, and 30 %. The lowest feed consumption was in the birds fed 10 % DBW. Therefore, it was not surprising that birds under this treatment had the best feed conversion (2.047 kg feed/kg weight). However, this value was significantly different from any of the other treatments. This result supports the finding of Damron *et al.* (1965), who reported that inclusion of up to 10 % DBW had no adverse effect on performance of broiler chicks.

No significant differences were obtained in cumulative livability. However, numerically, higher mortality was in birds fed, 20% DBW. It was assumed that this mortality was not due to the treatments since no clinical signs were observed on the birds and a very good livability was found in birds fed 30% DBW which was much higher than that observed in its preceding level.

Data presented in Table 7 show that treatment level had a significant but inharmonious response on dressing parameters of the broilers. The highest dressing percent was achieved when 10 % DBW was added to the diet. However, this result did not differ from that of 5 and 30%. To the best of our knowledge, there is no reference available to confirm or refute this result.

Dressing percent was significantly (P<0.01) affected by sex of the birds; female birds had higher dressing percent than males. This could be due to larger proportion of dressed female birds to their live body weight, while males had more inedible parts .

Conclusion: Data presented in this paper provided evidence that part of the corn can be successfully replaced with the Saudi Dried Bakery Waste in the diets of broilers. It should be emphasized though, that bakery waste may not be similar in contents in all countries of the world. For example, waste of bakeries from countries like USA or Europe may contain large amounts of sweets and fats, hence very high in energy while those produced in Saudi Arabia are mostly of breads and samoli which are less in energy. Therefore, it is suggested that the name “Dried Bakery Waste” when implied, should be preceded with source of the waste ”. The economics of using the bakery waste may fully depend on the availability of the waste and the demands for this product. Large animals are competing with poultry in using DBW in this country, therefore, the price may vary according to that.

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