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QUALITY CONTROL OF MEAT AND BONE MEAL USING RAPID ASSAY

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ABSTRACT

A rapid assay based on flotation / sedimentation technique was carried out to estimate ash, calcium and phosphorus along with CP and EE content of meat and bone meal (MBM). Forty samples of commercial MBM were assayed for ash, Ca, P, CP and EE using the standard procedures. Twenty gram of the assayed sample was mixed with 60 ml chloroform in 100 ml graduated cylinder, the bone precipitates to the bottom, meat floats and fats are dissolved. The precipitated bone was measured as ml. Bone volume (ml) was highly significant ($P<0.01$) correlated with ash, Ca, P and protein content of MBM. The correlation between bone volume and EE content was not significant. The resulted prediction equations to estimate ash, Ca, P, CP and EE in MBM samples are:

% Ash = -2.38 + 2.78 (ml bone), $R^2 = 0.81$
% Ca = 1.71 + 0.778 (ml bone), $R^2 = 0.59$
% P = 1.30 + 0.336 (ml bone), $R^2 = 0.37$
% CP = 70.90 – 1.771 (ml bone), $R^2 = 0.46$
% EE = 15.00 – 0.329 (ml bone), $R^2 = 0.07$

The relatively lower values of R^2 are mainly due to a reasonable consistency in the tested samples. It could be concluded that the use of such rapid assay can provide a reliable estimate of the Ca, P,CP and ash content of MBM.

INTRODUCTION

Meat and bone meal (MBM) is a common by-product. It is prepared from the waste materials associated with slaughtering operations (carcass trimmings, condemned carcasses, condemned livers, inedible offal (lungs and bones) and also from the rendering of dead animals. This ingredient is an excellent dietary source for protein, phosphorus and calcium, and the phosphorus in MBM is highly available (Waldroup and Adams, 1994; Sell, 1996; Sell and Jeffrey, 1996; Waldroup, 1999). With recent bans on the feeding of ruminant tissues to ruminants, MBM may find increased usage in poultry rations. Unfortunately, the quality of meals varies greatly, making difficult to precisely measure the nutrient availability (Elkin, 2002). Quality control programs are designed to protect aberrations in feed ingredient quality, but such programs usually cannot identify shipments of MBM with abnormally high or low Ca and P content prior to incorporation into mixed feeds. Because of the high volume and low inventory space of modern feed mills, many feed ingredients are already mixed into feeds and are on the farm before completion of detailed chemical analysis. Thus, the development of a rapid assay to detect abnormally high or low mineral levels in batches of MBM would be of significant value to quality control programs. Mendez and Dale (1998) introduced a rapid assay based on flotation / sedimentation

technique to estimate ash, calcium, crude proteins and phosphorus content of meat and bone meal (MBM).

The objective of this study was to evaluate the reliability of such quick test in predicting quality of MBM.

MATERIALS AND METHODS

A total of 40 samples of commercial meat and bone meals were collected from the Regional center for Food and Feed, the authorized lab for quality control of raw materials and finish feed in Egypt. The proximate composition and mineral composition of each sample was determined (AOAC, 1990). Volume of bone was determined using a 20 g sample according to the method described below.

A flotation / sedimentation technique was carried as described by Mendez and Dale (1998). Samples of 20 g of MBM were placed in a 100 ml graduated cylinder to which 60 ml of chloroform was added to each sample. The mixture stirred until all MBM was in suspension. Bone fragments were allowed to settle to the bottom of the cylinder for a period of 1 min and the volume of bone (in ml) was recorded.

Correlation of bone fraction (expressed as ml) with ash, Ca, P, CP and EE content was determined by standard statistical procedures (SAS, 1988) and prediction equations were developed**.**

RESULTS AND DISCUSSIONS

Table 1 shows the determined and predicted ash, Ca, P, CP and EE content along with the measured bone volume (ml) of the 40 tested MBM samples. Pronounced variations in composition of these samples were observed. Levels of ash ranged from 25.81 to 41.43%, Ca from 8.79 to 14.60%, P from 4.50 to 6.72%, crude protein from 43.10 to 54.20% and EE from 7.82 to 13.47%. The average values of ash, Ca, P, CP and EE of the 40 tested samples of MBM were 34.61, 12.07, 5.78, 47.33 and 10.62%, respectively. Mendez and Dale (1998) determined ash, Ca and P percentages of thirty samples of commercial MBM. Ash ranged from 13.58 to 42.34, Ca from 3.40 to 14.70 and P from 2.10 to 7.60 % with average values being 30.66, 10.50 and 5.11%, respectively.

Such variation in levels of Ca, P and protein between individual samples of MBM can cause problems in feed formulation. For example, if a broiler starter diet contained 6% MBM, which contained 5% available P, this ingredient alone would supply two-thirds of the available P requirement. Using the same amount of a batch of MBM with an abnormally low level of P could severely compromise chick performance.

The nutritive contents (protein, ash and fat) and protein quality of MBM can vary greatly depending on processing systems (extraction by pressure or by organic solvents), processing temperature and duration, and raw material source (Johnson and Parsons, 1997; Parsons *et al*., 1997; Wang and Parsons, 1998; Shirley and Parsons, 2000; Shirley and Parsons, 2001).

Flotation in organic solvents is a common technique employed by feed microscopists (Mendez and Dale, 1998). Microscopic evaluation is greatly facilitated by this type of separation: ash components of feed readily sink to the bottom of the vessel, solid organic components float, and lipids dissolve. MBM can easily be separated into its component fractions by chloroform flotation. It was hypothesized that if standard conditions were established, the bone fraction of MBM (and hence Ca, P, and ash) could be estimated employing the flotation technique.

From the determined values of ash, Ca, P, CP and EE content and the measured bone volume, prediction equations were developed to estimate ash, Ca, P, CP and EE from the value of bone volume. The resulted prediction equations are:

% Ash = -2.38 + 2.78 (ml bone), R^2 = 0.81
% Ca = 1.71 + 0.778 (ml bone), R^2 = 0.59
% P = 1.30 + 0.336 (ml bone), R^2 = 0.37
% CP = 70.90 – 1.771 (ml bone), R^2 = 0.46
% EE = 15.00 – 0.329 (ml bone), R^2 = 0.07

All these correlations were highly significant ($P<0.01$) except that of EE which was not significant. The low R squares are exactly what would be expected with reasonable consistency in the tested samples.

Mendez and Dale (1998) used the same assay and found a highly significant ($P<0.01$) relationship between volume of bone sediment and percentage of ash, Ca, and P, and the predication equations of ash, Ca, and P content of MBM samples were:

% Ash = 6.87 + 2.21 (ml bone), R^2 = 0.83
% Ca = 0.60 + 0.92 (ml bone), R^2 = 0.84
% P = 0.54 + 0.43 (ml bone), R^2 = 0.85

Although, the resulted equations and R^2 values seem to vary form those of Mendez and Dale (1998). Applying the resulted equations on their samples or their equations on our samples, identical results were obtained.

This proves that the assay is most useful as a rapid quality control test for MBM. As discussed with Dale (2007, Personal communications), the purpose of the assay is to quickly identify shipments of MBM that are very different in composition to what is expected. A decision then can be immediately made to verify the results of chemical tests reject the shipment or change the matrix in feed formulation program.

From the obtained results and forgoing discussion it could be concluded that the use of such rapid assay can provide a reliable estimate of the Ca, P and ash content of MBM, but the test is not recommended as a replacement for standard laboratory techniques. Rather, its use should be limited to the rapid detection of samples of MBM with abnormally high or low bone content so that quality control personnel can take appropriate action before the shipment is actually incorporated into finished feed.

Table 1. Determined and predicted ash, Ca and P contents of test samples

NO. of sample	Bone (ml)	Ash		Ca		P	
		Det.[1]	pred.[2]	Det.[1]	Pred.[2]	Det.[1]	Pred.[2]
1	10.50	25.81	26.80	9.25	9.88	4.52	4.84
2	11.50	26.58	29.58	8.79	10.66	4.79	5.18
3	11.50	28.15	29.58	10.56	10.66	4.50	5.18
4	12.00	29.70	30.97	11.04	11.05	5.64	5.35
5	12.50	30.00	32.36	11.64	11.44	5.04	5.52
6	12.00	30.70	30.97	11.54	11.05	5.30	5.35
7	12.00	32.70	30.97	11.44	11.05	5.23	5.35
8	12.50	32.41	32.36	12.62	11.44	6.16	5.52
9	13.00	32.77	33.75	11.04	11.82	5.91	5.68
10	12.00	33.08	30.97	11.84	11.05	5.80	5.35
11	13.00	33.22	33.75	11.92	11.82	6.00	5.68
12	13.00	33.26	33.75	11.44	11.82	5.69	5.68
13	13.00	33.75	33.75	11.60	11.82	6.25	5.68
14	13.00	34.27	33.75	11.84	11.82	5.65	5.68
15	13.00	34.36	33.75	11.95	11.82	5.72	5.68
16	13.50	34.37	35.14	11.36	12.21	6.10	5.85
17	13.50	34.85	35.14	11.97	12.21	5.56	5.85
18	13.50	35.18	35.14	12.16	12.21	5.75	5.85
19	13.50	35.20	35.14	12.35	12.21	5.12	5.85
20	14.00	35.23	36.53	12.00	12.60	5.08	6.02
21	14.00	35.61	36.53	12.00	12.60	6.51	6.02
22	14.00	35.78	36.53	11.44	12.60	5.67	6.02
23	13.00	35.80	33.75	13.02	11.82	5.79	5.68
24	13.00	35.81	33.75	12.24	11.82	4.93	5.68
25	14.50	36.03	37.92	11.92	12.99	5.64	6.19
26	14.50	36.09	37.92	12.80	12.99	6.35	6.19
27	13.00	36.17	33.75	12.40	11.82	6.31	5.68
28	14.00	36.27	36.53	13.04	12.60	6.56	6.02
29	13.00	36.29	33.75	12.88	11.82	5.85	5.68
30	14.00	36.34	36.53	13.20	12.60	6.15	6.02
31	14.75	36.55	38.62	12.32	13.19	4.92	6.28
32	13.00	36.56	33.75	11.95	11.82	5.98	5.68
33	14.00	36.65	36.53	11.95	12.60	5.94	6.02
34	14.25	36.76	37.23	12.75	12.80	6.11	6.11
35	14.50	36.99	37.92	12.40	12.99	6.66	6.19
36	14.50	37.40	37.92	13.52	12.99	6.08	6.19
37	14.00	37.40	36.53	12.92	12.60	5.98	6.02
38	14.00	38.22	36.53	13.04	12.60	6.72	6.02
39	15.50	40.81	40.70	14.00	13.77	6.40	6.53
40	15.00	41.43	39.31	14.60	13.38	6.71	6.36
Average	13.32	34.61	34.65	12.07	12.08	5.78	5.80
High	15.50	41.43	40.70	14.60	13.77	6.72	6.53
Low	10.50	25.81	26.80	8.79	9.88	4.50	4.84
SE	0.167	0.519	0.466	0.169	0.130	0.093	0.057

[1]**Determined values**
[2]**Predicted values**

Table 1. Cont. determined and predicted CP and EE contents of test samples

NO. of sample	CP		EE	
	Det.[1]	pred.[2]	Det.[1]	pred.[2]
1	49.20	52.32	13.12	11.58
2	54.20	50.55	12.74	11.25
3	52.60	50.55	11.12	11.25
4	50.30	49.66	10.20	11.08
5	49.60	48.78	13.47	10.92
6	49.75	49.66	11.87	11.08
7	50.20	49.66	10.25	11.08
8	45.90	48.78	9.36	10.92
9	47.70	47.89	11.58	10.75
10	51.80	49.66	9.43	11.08
11	47.10	47.89	11.85	10.75
12	45.90	47.89	11.43	10.75
13	47.60	47.89	11.91	10.75
14	48.70	47.89	9.42	10.75
15	45.30	47.89	10.74	10.75
16	49.80	47.01	10.32	10.59
17	47.30	47.01	11.85	10.59
18	48.20	47.01	10.60	10.59
19	47.80	47.01	10.94	10.59
20	48.00	46.12	10.04	10.42
21	45.10	46.12	9.45	10.42
22	45.30	46.12	11.41	10.42
23	50.60	47.70	9.27	10.75
24	44.60	47.70	10.17	10.75
25	47.20	45.24	11.67	10.26
26	46.80	45.24	10.64	10.26
27	50.00	47.70	7.82	10.75
28	43.10	46.12	12.70	10.42
29	43.60	47.70	9.34	10.75
30	49.60	46.12	10.61	10.42
31	44.50	44.79	11.65	10.17
32	50.00	47.70	9.77	10.75
33	44.10	46.12	10.72	10.42
34	44.40	45.68	8.56	10.34
35	44.80	45.24	10.88	10.26
36	44.70	45.24	9.75	10.26
37	44.00	46.12	9.34	10.42
38	44.30	46.12	8.96	10.42
39	45.40	43.47	10.32	9.93
40	44.30	44.35	9.50	10.09
Average	47.33	47.29	10.62	10.64
High	54.20	52.32	13.47	11.58
Low	43.10	43.47	7.82	9.93
SE	0.436	0.296	0.202	0.055

[1]**Determined values**
[2]**Predicted values**

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اختبار جودة مسحوق اللحم والعظم باستخدام اختبار سريع

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أجرى اختبار سريع يعتمد على طريقة الطفو والترسيب لحساب محتوى مسحوق اللحم والعظم من كل من الرماد والكالسيوم والفوسفور والبروتين والدهن. تم تقدير محتوى ٤٠ عينة من مسحوق اللحم والعظم من هذه المكونات الغذائية باستخدام الطرق الكيميائية القياسية التقليدية. أجرى اختبار الطفو والترسيب بخلط ٦٠ ملليمتر كلوروفورم إلى ٢٠ جرام من العينة فى مخبار مدرج سعته ١٠٠ مللي لتر حيث ترسب جزيئات العظم وتطفو جزيئات اللحم ويذوب الدهون ويتم قياس حجم العظم الراسب بالملي لتر. أظهرت النتائج الإحصائية وجود ارتباط معنوي بين حجم العظم ونسبة الرماد والكالسيوم والفوسفور والبروتين المقدرة بينما لم تظهر نسبة الدهن ارتباطا معنويا مع حجم العظم المترسب. ويمكن من المعادلات التالية توقع نسب مكونات مسحوق اللحم والعظم دون اللجوء إلى الطرق الكيميائية التقليدية:

الرماد% = - ٢,٣٨ + ٢,٧٨٠ (حجم العظم بالملي لتر)، الارتباط = ٠,٨١
الكالسيوم% = ١,٧١ + ٠,٧٧٨ (حجم العظم بالملي لتر)، الارتباط = ٠,٥٩
الفوسفور% = ١,٣٠ + ٠,٣٣٦ (حجم العظم بالملي لتر) ، الارتباط = ٠,٣٧
البروتين الخام% =٧٠,٩٠ – ١.٧٧١ (حجم العظم بالملي لتر)، الارتباط = ٠,٤٦
الدهن الخام%= ١٥,٠٠ – ٠,٣٢٩ (حجم العظم بالملي لتر)، الارتباط = ٠,٠٧

ويرجع انخفاض قيم الارتباط رغم معنويته الكبيرة إلى تقارب قيم التحاليل للعينات المختبرة. وبالتالي فإنه يمكن التوصية باستخدام هذه الطريقة السريعة لحساب نسبة الرماد والكالسيوم والفوسفور والبروتين في مسحوق اللحم والعظم التجاري.

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