# STUDY ON THE PROCESSING MEASURES OF PLANT PROTEIN MEAL TO ENHANCE PROPORTION OF RUMEN BYPASS PROTEIN

La Van Kinh, Nguyen Van Phu, Huynh Thanh Hoai, Nguyen Thi Yen

*Two experiments were conducted to estimate rumen bypass protein of plant protein meals (soybean seed, soybean meal, peanut meal, coconut meal and cottonseed meal) at various levels of heat treatment (temperature: 110, 125, 140 and 155$^0$C and duration of heating: 30, 60, 90 and 120 minutes).*

*In vitro assessment (protein fractionation according to CNCPS model and protein solubility in KOH) provided five treatments of each ingredient (4 best treatments and a non-treated one) for in sacco trial including:*

- *Soybean meal: 125-60, 125-90, 125-120 and 140$^0$C-30 minutes*
- *Peanut meal: 110-120, 125-30, 125-60 and 140$^0$C-30 minutes*
- *Coconut meal: 110-60, 110-90, 110$^0$C-120 and 125$^0$C-30 minutes*
- *Cotton meal: 110-60, 125-30, 125-60 and 140$^0$C-30 minutes*
- *Soy bean seed: 125-30, 125-60, 125-90 and 140$^0$C-30 minutes*
- *Extruded soybean meal: cooled after 10, 20, 30 and 50 minutes.*

*In sacco trial in 2 cross-bred Red Sindhi cattle at 2 times of taking samples from rumen (12 and 24 hours incubation) showed that the proportion of rumen un-degradable protein was highest at 125$^0$C-90 minutes for soybean meal, 125$^0$C-60 minutes for peanut meal; 110$^0$C-90 minutes for coconut meal; 140$^0$C-30 minutes for cottonseed meal; 125$^0$C-90 minutes for soybean seed and cooled after 50 minutes incubation for extruded soybean seed*

Key words: bypass protein, heat treatment, soluble/insoluble nitrogen, CNCPS.

## 1. INTRODUCTION

Feed's protein fed into rumen will be fermented by rumen microorganisms to become amino acids and at last become ammonia. Ammonia is the main nitrogen source to supply micro bacteria to synthesize their protein. High productivity dairy or beef need more high-quality protein from the diet than protein from rumen microorganism (Leng, 1991). Heat treatment intensified insoluble protein amount. Therefore, it would increase the amount of protein escaping rumen fermentation. In Vietnam, study on bypass protein has just been recently and rarely.

## 2. MATERIALS AND METHODS

Two experiments was conducted to estimate rumen bypass protein of plant protein meals (soybean seed, soybean meal, peanut meal, coconut meal and cottonseed meal) at various levels of heat treatment (temperature: 110, 125, 140 and 155$^0$C; duration: 30, 60, 90 and 120 minutes).

**Experiment 1:** *In vitro* assessment: measuring protein solubility of treatments using CNCPS model (Sniffen *et al.*, 1992; Licitra *et al.*, 1996) and protein solubility in KOH. Fractionation of protein under CNCPS model included non-protein nitrogen (fraction A), buffer soluble nitrogen (fraction $B_1$), neutral detergent soluble (fraction $B_2$), neutral detergent insoluble but acid detergent soluble (fraction B3), and acid detergent insoluble (fraction C). Combining results of protein fractionations and protein solubility in KOH, five treatments of each ingredients (4 best treatments and a non-treated one) were selected and used for experiment 2.

**Experiment 2:** An *in sacco* trial was conducted according to the method described

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by Orskov *et al.* (1980) on 2 cross-bred Red Sindhi cattle. Each ingredient consisted of 5 treatments, 2 times of taking samples from rumen (12 and 24 hours incubation), and 2 replications. Samples were washed, dried at $60^0$C and analyzed for dry matter and crude protein to estimate the rumen degradable and un-degradable proteins.

## 3. RESULTS AND DISCUSSION

### 3.1 Experiment 1:

Results from Table 1 showed that the neutral detergent soluble nitrogen ($B_2$) of materials increased with the augmentation of temperature and duration till the temperature reached $140^0$C and then declined. The fraction $B_2$ of all materials declined at $140^0$C-60' level.

The proportion of fraction $B_3$ over total nitrogen of peanut and coconut meals was quite high (40.9 and 51.3%) compared to the others (13.8% of soybean meal, 8.3% of cottonseed meal and 6.0% of soybean seed). The proportion of fraction $B_3$ also increased in accordance with the temperature and the effect of temperature level larger than the effect of treated time (Table 1). The nitrogen solubility in KOH 0.2% is an important measure to evaluate the ability digestion by enzyme in ruminant small intestine of treated heat materials. Except for coconut meal having low level of nitrogen soluble in KOH (29.3% over total nitrogen), the remaining had high level of nitrogen soluble in KOH (from 63.8% in peanut meal to 65% in the soybean meal, 81.7% in cottonseed meal and especially very high (up to 100%) in un-treated soybean seed. Heat treatment reduced the solubility of nitrogen in KOH, especially at the level of $140^0$C-60 minutes onward, except for the treatment at $155^0$C-30 minutes.

Table 1: analysis of protein fractions

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Neutral detergent soluble nitrogen ($B_2$), % over total nitrogen | | | | | | | | | | | | | | | | | |
| SBM | 57.8 | 61.7 | 58.1 | 61.5 | 62.1 | 65.0 | 65.9 | 64.0 | 64.2 | 65.3 | 56.9 | 50.2 | 38.9 | 52.8 | 19.1 | 10.3 | 6.9 |
| PNM | 26.7 | 24.8 | 34.0 | 31.0 | 32.2 | 36.3 | 40.9 | 38.4 | 31.0 | 35.5 | 30.7 | 15.4 | 11.6 | 32.6 | 8.6 | 5.0 | 1.4 |
| CCM | 25.3 | 28.9 | 28.2 | 24.3 | 24.6 | 27.4 | 19.5 | 13.8 | 14.7 | 17.6 | 12.7 | 2.5 | 0.6 | 13.7 | 0.8 | 0.9 | 0.5 |
| CSM | 48.5 | 51.9 | 59.9 | 60.3 | 61.8 | 57.3 | 55.8 | 55.3 | 55.5 | 55.7 | 56.8 | 50.5 | 36.0 | 25.5 | 10.3 | 9.6 | 6.8 |
| SB | 41.4 | 36.0 | 33.2 | 41.1 | 37.5 | 13.7 | 22.9 | 41.9 | 41.0 | 43.4 | 33.2 | 20.7 | 21.5 | 44.0 | 14.4 | 15.3 | 15.3 |
| Acid detergent soluble nitrogen ($B_3$), % over total nitrogen | | | | | | | | | | | | | | | | | |
| SBM | 13.8 | 14.8 | 18.4 | 18.9 | 17.7 | 14.3 | 17.9 | 21.4 | 20.2 | 18.8 | 32.1 | 38.8 | 51.9 | 35.6 | 69.7 | 80.4 | 83.0 |
| PNM | 40.9 | 42.3 | 41.9 | 45.6 | 43.7 | 36.3 | 40.2 | 40.9 | 45.0 | 41.0 | 43.5 | 58.3 | 59.6 | 46.3 | 61.7 | 59.6 | 52.6 |
| CCM | 51.3 | 49.6 | 50.6 | 54.0 | 54.1 | 48.9 | 57.4 | 61.9 | 61.2 | 58.5 | 59.5 | 61.8 | 58.2 | 65.2 | 60.4 | 50.0 | 42.1 |
| CSM | 8.3 | 6.8 | 7.4 | 6.8 | 7.1 | 9.6 | 10.1 | 13.4 | 14.4 | 16.6 | 18.9 | 27.7 | 42.8 | 53.3 | 64.8 | 66.1 | 65.1 |
| SB | 6.0 | 10.5 | 13.3 | 13.2 | 9.5 | 31.6 | 32.0 | 34.1 | 35.6 | 35.1 | 44.9 | 60.4 | 61.6 | 36.4 | 56.2 | 51.1 | 39.5 |
| KOH soluble nitrogen, % over total nitrogen | | | | | | | | | | | | | | | | | |
| SBM | 65.0 | 62.3 | 60.4 | 59.1 | 57.8 | 60.1 | 55.9 | 54.7 | 53.6 | 52.4 | 35.1 | 19.1 | 20.6 | 34.4 | 15.1 | 5.7 | 4.7 |
| PNM | 63.8 | 56.0 | 52.9 | 52.1 | 55.8 | 56.0 | 50.3 | 40.6 | 39.5 | 43.7 | 29.3 | 16.3 | 12.9 | 34.1 | 10.9 | 8.2 | 6.0 |
| CCM | 29.3 | 27.1 | 26.1 | 27.4 | 24.8 | 22.4 | 16.4 | 13.9 | 12.6 | 13.5 | 10.6 | 10.2 | 9.9 | 18.0 | 10.6 | 8.1 | 7.3 |
| CSM | 81.7 | 78.1 | 76.3 | 68.1 | 67.1 | 70.2 | 68.9 | 61.1 | 49.2 | 65.2 | 45.3 | 37.3 | 29.8 | 17.9 | 13.7 | 15.3 | 11.9 |
| SB | 99.3 | 95.1 | 90.6 | 87.4 | 64.7 | 83.6 | 81.3 | 73.1 | 57.8 | 66.6 | 41.7 | 17.2 | 21.0 | 52.1 | 21.2 | 17.0 | 14.6 |

*Notes: Treatment: 1. ingredient; 2. 110-30; 3. 110-60; 4. 110-90; 5. 110-120; 6. 125-30; 7. 125-60; 8. 125-90; 9. 125-120; 10. 140-30; 11. 140-60; 12. 140-90; 13. 140-120; 14. 155-30; 15. 155-60; 16. 155-90; 17. 155-120'; SBM. Soybean meal; PNM. Peanut meal; CCM. Coconut meal; CSM. Cottonseed meal; SB. Soybean seed.*

From the above-mentioned results, treatments were selected for *in sacco* trial including: treatments 7, 8, 9, 10 for soybean meal; treatments 5, 6, 7, 10 for peanut meal; treatments 3, 4, 5, 6 for peanut meal; treatments 3, 6, 7, 10 for cottonseed meal; treatments 6, 7, 8, 10 for soybean seed and treatments cooled after 10, 20, 30, 50 minutes for extruded soybean seed.

### 3.2 Experiment 2

Table 2 showed that the longer of the incubation time in the rumen was the lower level of un-degradable nitrogen. The higher of un-degradable nitrogen rate is the higher nitrogen escaped from the rumen to the lower tract (abomasum and small intestine). Heat treatment strongly affected the degradability of nitrogen in the rumen. Increasing temperature and duration of treatment would increase the proportion of rumen un-degradable nitrogen, meaning increase rumen bypass protein. *In sacco* results showed that the best treatments for rumen bypass protein were $125^0$C - 90 minutes for soybean meal; $125^0$C-60 minutes for peanut meal; $110^0$C-90 minutes for coconut meal; $140^0$C-30 minutes for cottonseed meal; $125^0$C-90 minutes for soybean seed and cooled after 50 minutes for extruded soybean.

Table 2: dry matter and protein degradability ratios in rumen

| | Soybean meal | | | | | Peanut meal | | | | | Coconut meal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | 1 | 7 | 8 | 9 | 10 | 1 | 5 | 6 | 7 | 10 | 1 | 3 | 4 | 5 | 6 |
| UN 12h | 41.1 | 49.7 | 50.6 | 51.6 | 51.6 | 42.1 | 51.5 | 51.6 | 56.1 | 53.7 | 44.0 | 49.0 | 50.5 | 52.6 | 54.0 |
| UN 24h | 30.4 | 38.3 | 41.9 | 41.0 | 39.4 | 34.6 | 44.1 | 44.8 | 47.1 | 45.5 | 35.7 | 41.8 | 44.8 | 42.1 | 44.0 |
| | Cottonseed meal | | | | | Soybean seed | | | | | Extruded soybean seed | | | | |
| Treatments | 1 | 3 | 6 | 7 | 10 | 1 | 6 | 7 | 8 | 10 | CI | A10 | A20 | A30 | A50 |
| UN 12h | 44.3 | 52.5 | 51.0 | 55.0 | 55.6 | 38.6 | 40.8 | 44.5 | 47.3 | 43.8 | 61.7 | 67.5 | 67.2 | 69.3 | 71.6 |
| UN 24h | 32.8 | 41.8 | 41.4 | 41.5 | 41.9 | 18.1 | 26.2 | 28.4 | 31.6 | 27.7 | 36.9 | 40.5 | 43.4 | 42.9 | 46.6 |

*Notes: Treatment: 1. ingredient; 3. 110-60; 4. 110-90; 5. 110-120; 6. 125-30; 7. 125-60; 8. 125-90; 9. 125-120; 10. 140-30'; CI. cooled immediately; A10. after 10; A20. after 20; A30. after 30; A50. after 50 minutes; UN. Undegradable nitrogen.*

## 4. CONCLUSIONS

- *In vitro* assessment (protein fractionation according to CNCPS model and protein solubility in KOH) provided the best treatments, including:

  + Soybean meal: 125-60, 125-90, 125-120 and $140^0$C-30 minutes

  + Peanut meal: 110-120, 125-30, 125-60 and $140^0$C-30 minutes

  + Coconut meal: 110-60, 110-90, $110^0$C-120 and $125^0$C-30 minutes

  + Cotton meal: 110-60, 125-30, 125-60 and $140^0$C-30 minutes

  + Soy bean seed: 125-30, 125-60, 125-90 and $140^0$C-30 minutes

  + Extruded soybean meal: cooled after 10, 20, 30 and 50 minutes

- The proportion of rumen un-degradable protein was highest at $125^0$C-90 minutes for soybean meal, $125^0$C-60 minutes for peanut meal; $110^0$C-90 minutes for coconut meal; $140^0$C-30 minutes for cottonseed meal; $125^0$C-90 minutes for soybean seed and cooled after 50 minutes incubation for extruded soybean seed.

## REFERENCES


Leng, R.A., 1991. Feeding strategies for improving milk production of dairy animals managed by small-farmers in the tropics. In *"Feeding dairy cows in the tropics"*. FAO Animal production and health paper 86.

Licitra, G., T.M. Hernandez and P.J. Van Soest 1996. Standardization of procedures for nitrogen fractionation of ruminant feeds. *Animal Feed Science Technology*, **57**: 347-358.

Orskov, E.R., Hovell, D and Mould, F.L., 1980. The use of the nylon bag technique for the evaluation of feedstuffs. Tropical Animal Production, **5**: 195-213.

Sniffen, C.J., J.D. O'Connor, P.J. Van Soest, D.G Fox and J.B. Russel. 1992. A Net Carbohydrate and Protein System for Evaluating Cattle Diets: II. Carbohydrate and Protein Availability. *Journal of Animal Science*, **70**:3562-3577.