OILSEED MEALS AND THE EFFECT OF PROCESSING ON THEIR SUBSEQUENT QUALITY

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SUMMARY

Soybean protein product quality is a function of soybean quality and processing conditions. Numerous factors have been shown to affect soybean quality; variety, planting practices, weather conditions, soil characteristics, fertilisation rates, storage conditions and several other conditions. Processing condition factors are related to the quality of heat treatment, moisture level and for soybean protein concentrates, the extraction method is also involved.

INTRODUCTION

The processing of soybeans had been refined over the last 50 years. The outline of the process is shown in Fig. 1. Briefly, the process has three components.

1. Preparation for hexane extraction.
2. Hexane extraction
3. Recovery of hexane

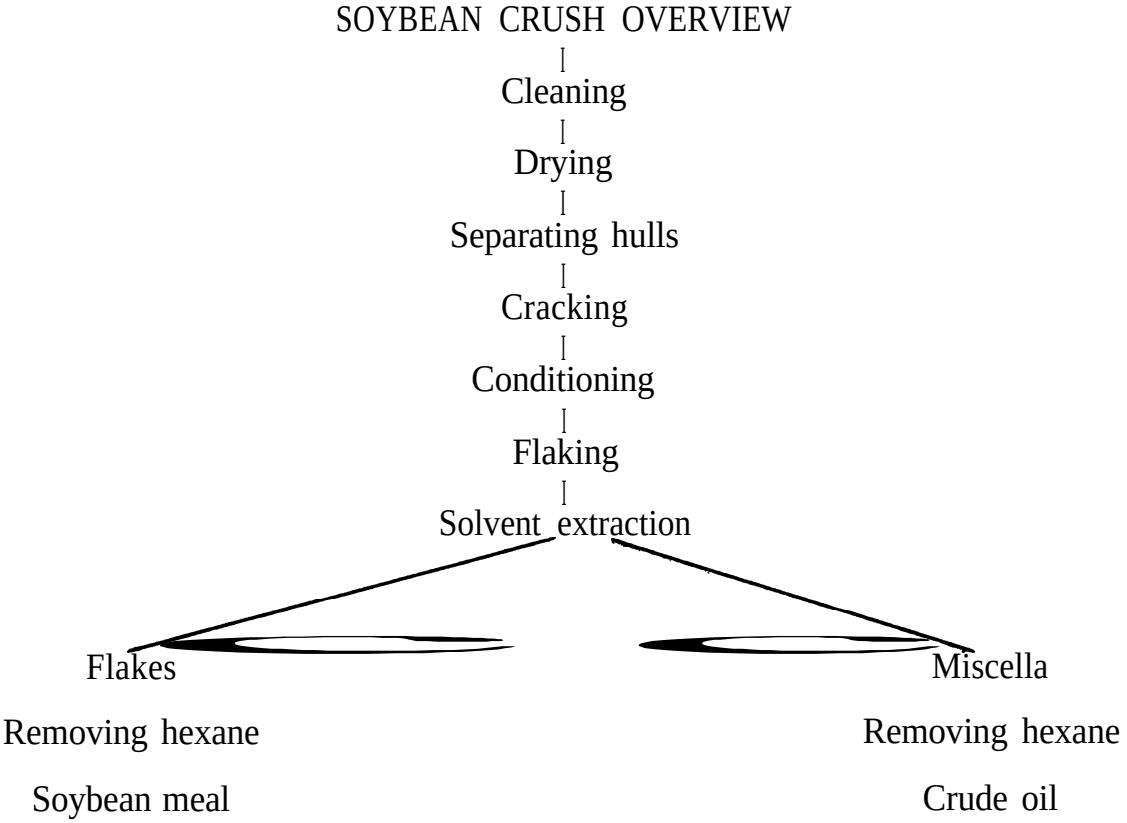

Figure 1 Outline of soybean processing

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DESOLVENTIZER TOASTER

The quality of the soybean meal is most affected by the quality of the raw soybeans and by the process of removing the hexane. Before discussing the quality parameters, I want to discuss the process of hexane removal. The equipment which is used is called a desolventizer toaster; industry jargon shortens this to DT (Fig. 2).

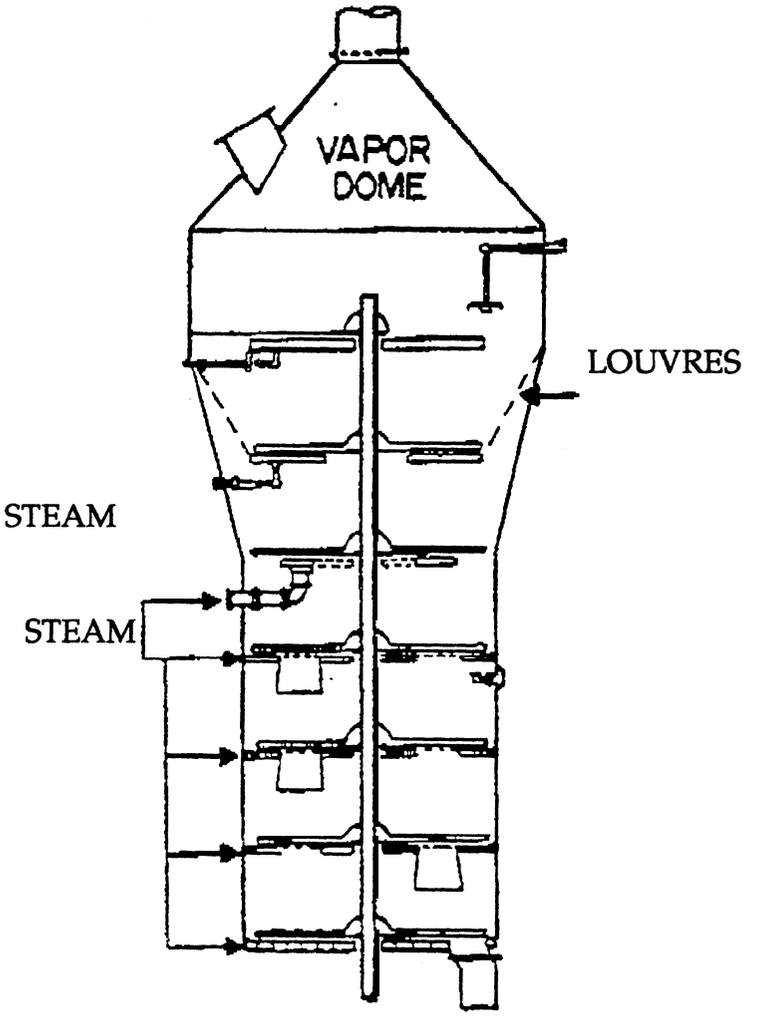

Figure 2 Desolventizer toaster (DT)

The soyflakes drenched in hexane are fed into the top of the DT. The product comes in contact with steam which is used to remove the hexane in the upper three trays and to increase the effectiveness of the subsequent heating (toasting) in the lower trays. The toasting is required to inactivate the antinutritional factors in the soybeans **and** to denature the protein to make it more digestible. The function of the DT is critical for soybean meal quality. It is also critical for the process, i.e., the recovery of hexane. In summary, there must be enough heat and moisture but not too much.

RESULTS

Some typical operation parameters are shown in Table 1.

Table 1 Typical operation conditions for desolventizer toasters

	Processing facility			
	A	B	C	D
DT Vapour Temp (°F)	150	153	165	146
DT Discharge Temp (°F)	225	218	200	227
Retention Time (min)	65	38	10	NA
Sparge Steam (# Stm/Bu Beans)	2.98	7.40	NA	6.20

It is clear that the balance of time and temperature will determine the quality of today's soybean meal. It is my opinion that undertoasting is no longer an issue, at least in the U.S. Consequently, I shall not address undertoasting. However the potential does exist for overtoasting.

Table 2 Proximate compositions of soybean protein products

	Soybean meal		Soy protein	Soy protein
Nutrient (%)	44	47	concentrate	isolate
Moisture	12	12	7	5
Protein	44	47	66	87
Fat	0.5	0.5	0.3	---
Fibre	7.0	3.0	3.5	0.2
Ash	6.0	6.0	5.6	2.8
Trypsin inhibitor (Units/mg)	6-15	6-15	2-20	8-21

SOYBEAN MEAL QUALITY TESTS

It has long been recognised that the nutritive quality/value of soybean meal will be reduced if exposed to excessive heat, or for that matter not enough heat. Damage to such amino acids as lysine could reduce animal performance. For several years, colour has been used as an indicator of quality. But with new processing technology and our ability to apply a more even heat distribution, the colour can no longer be used.

I would like to spend a little time discussing the various quality tests. These tests and inferences are:

a) TRYPSIN INHIBITOR

1) Kakade method (Cereal Chemistry 5,376 (1943)
2) Official AOCS BA 12-75 (1983)
3) Unilever method
4) ADM method (available on request)

b) UREASE TEST

1) AOCS BA 9-58 (1973)
2) EEC technique

c) KOH ANALYSIS

1) Available on request

d) PROTEIN DISPERSIBILITY

1) AOCS BA 10-65 (1979)

e) CRESOL RED TEST

1) Otomucki and Burnstein (1960)
2) Orange G. Binding (Udy 1956, Moran et al. 1976)

f) LYSINE AVAILABILITY

1) Carpenter technique
2) DNFB (AOAC 43.278)

g) COLOUR COMPARISON

1) Hunterlab test

Trypsin inhibition has received the greatest attention because it has been determined to cause 40% of the growth depressing and pancreatic hypertrophy effects of raw soybeans fed to rats. Soybean trypsin inhibitors (TI) interfere with the activity of the enzymes, trypsin and chymotrypsin, the important protein digestive enzymes in animals. There are several TI in soybeans, but the protein soybean trypsin inhibitors contribute most to the inhibition activity.

Table 3 Relationship between in vitro tests and performance of chicks fed heated soybean meal (Experiment 2)

Treatment (minutes)	Urease activity[1]	Protein solubility (%)	Weight gain[2]	Feed/ gain
0	0.00	82.3	423ab	2.26
5	0.00	72.6	452a	1.12a
10	0.00	66.9	444a	2.24a
20	0.00	60.5	405c	2.36a
40	0.00	46.1	254d	2.60b

abcd ($p \leq 0.05$) [1] pH change [2] g/chick (0-21 days)

Table 4 Effect of particle size on protein solubility

Particle size (pass/retain) µm/µm	Mesh # size	Protein protein (%)	Protein solubility (%)
2000/1180	10/16	48.6	34.2
1180/841	16/20	48.3	44.5
841/425	20/40	47.4	51.4
425/300	40/50	45.7	56.7
300/250	50/60	44.7	57.7
250/180	60/80	43.7	59.0
180/150	80/100	42.7	59.2
150/75	100/200	41.3	58.1
< 75	200	41.2	60.0

Table 5 Effect of oil content on protein solubility

Sample	Oil content	Protein solubility (%)
1	13.3	79.8
2	10.5	76.7
3	8.9	79.2
4	8.0	80.3
5	7.5	79.0
6	0.2	80.4

Tables 4 & 5 Source: 26th Nutrition Conference for Feed Manufacturers University of Guelph. N. Dale and M. Araba pp 42-52

CONCLUSION

The results of these studies support earlier work indicating that urease values are of limited use in detecting or quantifying the overprocessing of soybean meal. Urease values rapidly decline to 0.00 at which point the meal may or may not be overprocessed. As there is no negative scale in the urease system, urease values are insensitive to degree of overprocessing. By contrast, protein solubility values decrease with each increase in processing time and even with severe overprocessing do not approach 0.00.

Urease values are of greater use in detecting underprocessed soybean meal. However, if a quality control laboratory can justify the use of only one test per sample of soybean meal, the solubility test would appear to be the assay of choice. The range of solubilities from approximately 73% to 85% appear to be consistent with optimum soybean meal processing. However, further studies are needed with meals both overprocessed and underprocessed under commercial conditions to better define the limit in protein solubility associated with optimum performance.

METHOD FOR DETERMINING PROTEIN SOLUBILITY ON SOYBEAN MEAL

Reagents:

Potassium hydroxide (KOH) 0.2%, equals 0.042 normal (pH 12.5).

Other reagents necessary are those standard for the determination of protein by the kjeldahl method.

To prepare the KOH reagent take 2.360 g of KOH in a volumetric flask, dissolve with water and dilute to 1000 ml. Remember to compensate for the percent purity of the KOH.

Procedure:

"Take 1.5 g of soybean meal in a 250 ml beaker, add 75 ml KOH solution and allow to stir for 20 min.

After allowing it to stir for 20 min, transfer 50 ml of the liquid to a centrifuge tube and centrifuge for 10 min at 2700 rpm.

Take a 15 ml aliquot for determination of kjeldahl protein.

Determine the protein on this 15 ml aliquot by a standard kjeldahl method. This 15 ml aliquot if done according to our procedure is equivalent to 0.3 g of the original sample.

Calculation:

$$\text{Protein solubility (\%)} = \frac{\text{Protein (\%) in 0.3 g portion of sample}}{\text{Protein (\%) of original sample}}$$

In our laboratory we have a tecator system and we run a crude protein on a 1 g portion of the original sample and as mentioned above, the crude protein on the 15 ml is equivalent to running a crude protein of a 0.3 g portion of sample.

Note: Care should be taken when comparing different soybean meals that they are of comparable particle size. The stirring time in the KOH should be carefully monitored so, the stir times are the same in all cases.