SOYBEAN AND ITS PROCESSING PRODUCTS IN THE NUTRITION OF CALVES

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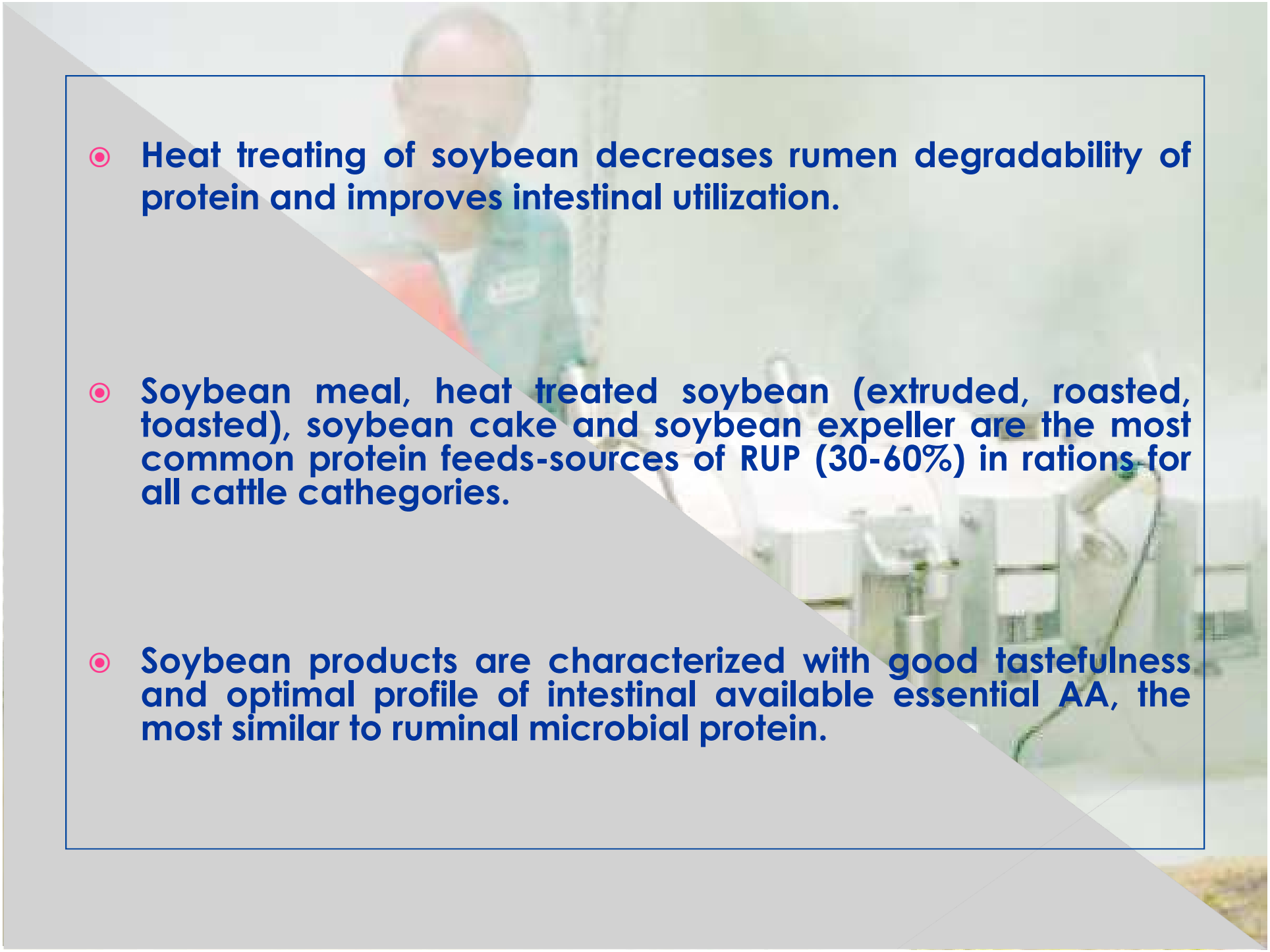
INTRODUCTION

- Soybean and products of different technological processes of treating, in terms of intensive cattle production, are primary and necessary feed-source of dietary protein.
- Soybean and products of processing are particularly important feeds-sources of high-quality protein in young cattle nutrition.
- Beside of high protein content (39%) with favorable amino acids composition, soybean is rich in fat (20%), phospholipids, trace elements and vitamins.

NUTRITIONAL CHARACTERISTICS OF SOYBEAN AND SIGNIFICANCE OF HEAT TREATMENT

- Heat treatment of soybean is common method for inactivation of the most of antinutritional factors in row soybean.
- The most of the antinutritional components in soybean are partially or completely inactivated by appropriate heat treatments as roasting, extruding, micronization and toasting are.
- As heat treatment is common method for inactivation of antinutritional components in soybean, simultaneously it is used for reducing protein ruminal degradation.



- Heat treating of soybean decreases rumen degradability of protein and improves intestinal utilization.

- Soybean meal, heat treated soybean (extruded, roasted, toasted), soybean cake and soybean expeller are the most common protein feeds-sources of RUP (30-60%) in rations for all cattle cathegories.

- Soybean products are characterized with good tastefulness and optimal profile of intestinal available essential AA, the most similar to ruminal microbial protein.

EFFECTS OF USING SOYBEAN PRODUCTS IN PERIOD OF LIQUID NUTRITION OF CALVES

- Milk replacers containing entirely milk protein are based on skim milk powder, whey protein concentrate, whey powder or delactosed whey.

- Toward to formulating economically acceptable milk replacers, the most common used alternative and low-cost sources of protein in milk replacers are soybean flour, soybean protein concentrate and soybean protein isolate that are characterized with high digestibility and utilization.

Table 1. Chemical composition of soybean products (% DM) that are used in milk replacers.

Item	Soybean flour	Soybean protein concentrate	Soybean protein isolate
Crude protein	56.0	72.0	95.6
Ether extract	1.0	0.3	0.6
Sugars	16.0	1.0	-
Polysaccharides	15.0	20.0	0.5
Ash	6.0	5.0	3.3
Other components	6.0	1.0	-

- Substitution of 50% of milk protein with soybean protein concentrate in milk replacers, at calves 1-14 days of age, decreased average daily gain by 32.5% and FCR by 33.3% (*Tomkins at al. 1994*).

- This milk replacers used for feeding calves until 42 days of age with, decreased average daily gain by 7.1% and feed conversion ratio by 5.9%.

- This pointing that calves at age later than two weeks are more tolerant on soybean protein .

- Plant proteins should be used in milk replacers for calves after third week of age.

- Using of soybean proteins in milk replacers commonly affects adversely on production performances of calves, caused by impossibility of soybean proteins to coagulate in abomasum of calves, inducing of allergic reaction in gastrointestinal tract.

- Intestinal mucosa histomorphological changes were registered (decreasing of villi length and crypts depth) at calves fed milk replacers with soybean flour or soybean protein concentrate, and this could be explained by abrasive effect of present fibers cellulose and hemicellulose.

- Series of other negative effects on enterocytes of intestinal mucosa were found at young calves: reducing capacity for protein synthesis, decreasing activity of digestive enzymes, reducing of absorption capacity, increasing of mucus secretion, immune activity and endogenous protein losses.

Table 2. Performances of calves (30-130 days) fed milk replacer with completely milk protein (MP), milk replacer with 56% protein from hydrolyzed soybean protein isolate (HSPI), and milk replacer with 72% protein from heated soybean flour (HSBF), (*Lallès et al. 1995*).

Item	MP	HSPI	HSBF
Initial BW, kg	53.9	53.4	53.4
Final BW, kg	165.6	156.9	135.8
Average daily gain, kg/day	1.23	1.14	0.89
Feed conversion, kg/kg of gain	1.60	1.68	2.15
Cold carcass weight, kg	103.6	99.9	81.5
Digestibility, %			
Dry matter, DM	95.5	93.7	81.3
Organic matter, OM	96.2	94.8	82.7
Nitrogen, N	94.4	91.5	68.6
Ether extract	92.0	89.0	84.1
Nitrogen free extract, N.F.E.	98.7	98.5	88.4
Ca	79.8	76.8	53.7
P	94.0	91.3	75.7
Retention, g/day			
N	38.0	35.8	30.1
Ca	19.3	18.1	13.6
P	11.2	11.4	9.2
Antibody titers in blood plasma, 74. day			
Against denatured proteins from HSPI	0	1.6	3.1

- In this researching, hydrolyzed soybean protein isolate did not show antibody activity of glycinin and β-conglycinin, while contents of these immunoreactive proteins were 3.94 and 3.61%, respectively, in heated soybean flour. In untreated defatted soybean flour contents of glycinin and β-conglycinin with antigenic activity were 26.9 and 19.4%.

- Antitrypsin activity of HSPI was 3.1 TUI (Trypsin Units Inhibited)/mg CP, while this value for HSBF was 18.0 TUI/mg CP. In row soybean flour, antitrypsin activity was 87 TUI/mg CP.

- Average daily gain, digestibility of DM, AA, N and retention of N were increased when calves fed milk replacer where 50% of milk protein was substituted with heat treated and defatted soybean flour, added with **synthetic AA: DL-methionine (0.13%), L-lysine (0.60%) and L-threonine (0.27%),** compared with calves fed milk replacer with soybean flour, without synthetic AA (*Kanjanapruthipong, 1998*).

Table 3. Production performances of calves fed milk replacer based on skim milk powder and whey powder (MP), milk replacer with soybean flour (SBF), and milk replacer with soybean flour with added synthetic AA (SBFAA),(*Kanjanapruthipong, 1998*).

Item	MP	SBF	SBFAA
Intake DM, g/day	671.2	680.0	671.2
Intake N, g/day	22.5	22.8	22.5
Average daily gain, g/day	388.0	244.3	308.5
Digestibility DM, %	92.3	80.9	82.2
Digestibility N, %	84.9	66.7	68.4
Retention N, g/day	13.4	8.0	10.4

- Soymilk can be efficiently used for substitution of part of fullfat milk (up to 50%) in diets for young calves, without negative effect on calves health, average daily gain and feed efficiency, while costs of weaning is decreased by 35% (*Ghorbani et al. 2007*).

- Calves consumed soymilk, more rapid achieved concentrate intake of 900 g/day (parameter for weaning time).

Table 4. Effect of substitution of part (25 and 50%) of fullfat milk (M) with soymilk (SM), on production performances of calves (*Ghorbani et al. 2007*).

Item	M	SM-25	SM-50
BW at 49. day, kg	68.3	68.0	65.3
Total gain, kg	26.4	26.4	23.8
Total DMI, kg	45.8	50.8	45.6
Feed conversion, kg of gain/kg feed DM	0.58	0.52	0.54
Age at 900 g/day starter intake, day	58.4	52.1	49.8
BW at 900 g/day starter intake, kg	71.4	64.4	61.1

SIGNIFICANCE OF USING OF HEAT TREATED SOYBEAN IN CALVES NUTRITION

- Using of heat treated soybean in young cattle nutrition is according to his nutritional value, positive effect on production performances, and quality of realized production.
- Effect of including soybean in diet for calves depends of dietary level, applied method of treating and exact production system.
- Young calves require high concentration of energy and protein in ration.

- Heat treatment of soybean reduces content of soluble N and increases content of N fraction bind to fibers, relative to row soybean.

- This could be explain by Maillard reaction (amino-sugar complexes) that reduces solubility of N, partially these complexes retained in NDF and ADF fractions (trough out sequentially fractionation of fibers).

- Heat treated soybean that is characterized with high content of quality protein (with high proportion of RUP, 39-62%) and high level of oil, improves N balance, provides efficiently protein utilization, sufficiently supplying of available AA and improve performances of calves (*Stojanović, 2006*).

- According to *Abdelgadir et al.* (1996), using of roasted soybean (138°C) in combination with roasted corn (135°C), improved production performances of Holstein calves (daily gain, feed conversion, energy utilization efficiency) at age of 1-8 weeks (weaned at 6 weeks).

- Ruminal concentration of NH_3 was higher at calves fed soybean meal, relative to calves consumed diets with roasted soybean-138 and 146° C (2.8, 1.3 and 1.6 mM, respectively) due to different contents of RDP (70, 55 and 48%, respectively).

- Blood urea concentration in calves at age of 8 weeks was higher for calves fed soybean meal (2.75, 2.31 and 2.58 mM, respectively), and these results can be explained with higher ruminal concentration of NH_3.

- *Albro et al.* (*1993*) reported that using of extruded soybean in rations for steers did not affect average daily gain, but improved feed conversion, compared with rations based on soybean meal.

- Substitution of soybean meal with extruded soybean in diets for young cattle provides increasing of feed efficiency, followed with reducing of dietary DM intake, due to higher dietary energy concentration, lower level of methane production, and higher metabolic efficiency of fat retention (*Stojanović et al. 2008*).

- This effect is more expressive when extruded soybean was used with heat treated (micronized) corn in mixture for weaned calves.

Table 7. Effects of using extruded soybean and micronized corn in mixture for weaned calves (*Stojanović et al. 2008*).

Item	SM	ES	ESMC
Initial BW, kg	62.5	64.6	65.5
Final BW, kg	121.0	121.6	123.2
DM intake, kg/day	2855.0	2755.6	2633.8
Feed conversion, kg/kg of gain	2.93	2.88	2.76
Utilization efficiency of ME MJ/kg of gain	35.92	35.77	33.96
Utilization efficiency of CP g/kg of gain	598.49	580.7	540.29
Glucose concentr. in blood serum, mmol/l	4.03	4.13	4.30
Urea concentr. in blood serum, mmol/l	3.44	3.13	2.81

SM-Mixture with soybean meal
ES-Mixture with extruded soybean
ESMC- Mixture with extruded soybean and micronized corn

- Using of heated soybean in mixtures for calves can reduce dietary starch concentration and enable formulating of diets with high energy concentration, with avoiding of ruminal acidosis appearance.

- Favorable effect of using of soybean is greater when concentrated diets for calves are applied, due to lower interaction with fibers digestibility.

- However, it is recommended that portion of soybean in calves' rations should be limited at 20%, due to avoiding adverse effect on rumen digestibility and tastefulness of diets (*Mateos et al. 2002*).

- *Maiga et al. (1994)* in experiment with Holstein calves (1-12 weeks) found higher daily gains at calves fed mixture with extruded soybean meal relative to calves consumed commercial soybean meal (0.76 and 0.71 kg/day), dietary DM intake was improved to (1.43 and 1.32 kg/day). This was explained as a result of increased content of RUP.

- Using of extruded soybean, instead of soybean meal, especially in combination with heat treated corn in mixtures for weaned calves (60-120. days), improves feed digestibility (110. day), (*Stojanović et al. 2007b*).

Table 8. Effect of using extruded soybean and micronized corn in mixture for weaned calves on feed digestibility (%), (*Stojanović et al. 2007b*).

Nutrient	SM	ES	ESMC
Dry matter	76.09	77.25	79.73
Organic matter	78.33	78.06	81.91
Crude protein	71.51	72.14	76.25
Crude fiber	53.95	52.75	50.90
Ether extract	88.66	87.36	85.77
NFE	83.35	84.50	89.57

SM-Mixture with soybean meal
ES-Mixture with extruded soybean
ESMC- Mixture with extruded soybean and micronized corn

- At contrary, *Griffin et al.* (*1993*) in assay with steers (initial BW of 240 kg) found that using mixture based on soybean meal (44% CP) increased utilization and retention of N, compared with using row or extruded soybean.

- Intestinal digestibility of AA in extruded soybean was 86%, while in soybean meal was 93%.

- In experiment with female calves (initial BW of 101 kg), *Devant et al.* (*2000*) concluded that increasing of dietary concentration of RUP (using heat treated soybean meal, instead of commercial soybean meal) in mixtures, increased excretion of N by feces (35.8 and 29.7 g/day).

- Although nonenzymatic reactions that cause protein denaturation in heat treated feeds reduce AA availability for ruminal microflora, also commonly reduce intestinal availability of AA, too.

CONCLUSION

Using of soybean products in calves' nutrition has according to their nutritional value, positive effects on production performances, and quality of realized production. Effect of including soybean products in diet for calves depends of dietary level and applied method of processing.

Soybean products, primarily soy protein concentrate and soy protein isolate are widely used as protein sources in milk replacers for calves. Soybean proteins should be used in milk replacers for calves after three weeks of age, at the level of up to 50% of total protein content.

Using of heat-treated soybean in diets for calves, increases content of rumen undegradable protein and fulfills the needs in essential amino acids, and achieves high energy concentration of diets. Using of heat treated soybean in complete mixtures for calves increases feed conversion ratio, utilization of consumed nutrients and energy, and provides better average daily gains.

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