Nutritional Disorder and Feeding Standard in Cows

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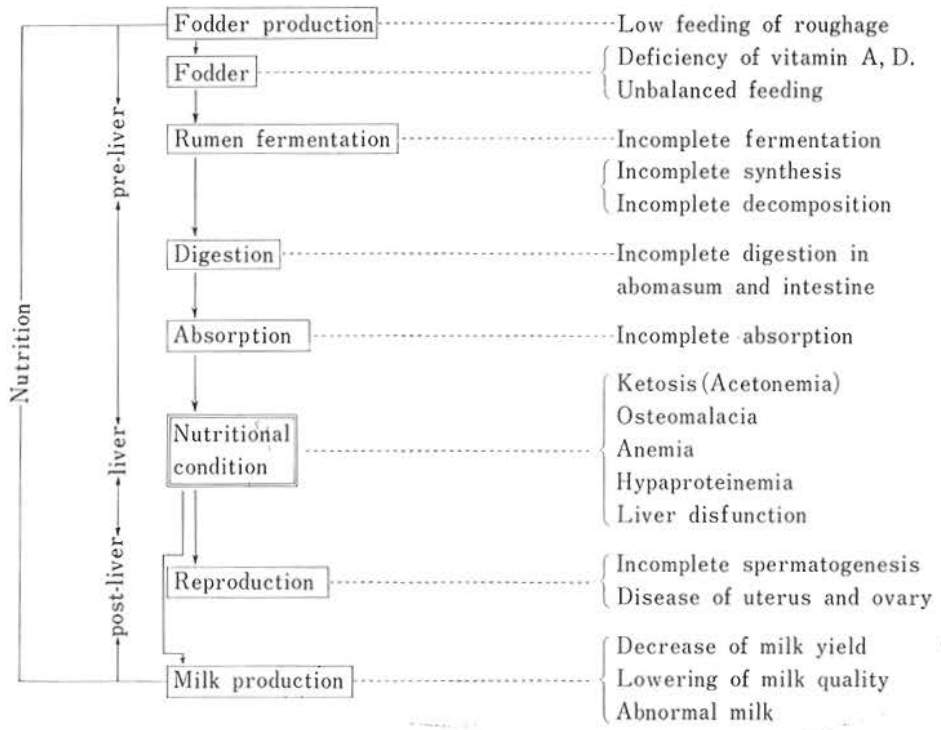
The problem of nutritional disorders in cows has two sides of feeding and animal as seen in Table 1 and the various causes of the disorders are complicated. In this paper, the problem will be limited in considering feeding, especially feeding based on its standard in describing the relation existing between feeding and the nutritional disorder in cows.

As to the feeding standard in cows, those of NRC, Morrison, Kellner, Woodman and Hansson are cited as representative ones. However, there is practically no report on the problem of what are the changes or disorders induced in cows fed on a diet superflucus or deficient in the amount of DCP and TDN as compared with those standards.

It is said that the nutritional condition of cows is related to their useful life, reproduction and milk yield. However, the excess of

Table 1. Points problems of nutritional disorder in cows



protein and carbohydrate intakes is not closely related to the useful life, and excessive fat has a bad influence upon it. It has been reported that the reproduction of cows was good when they were fed on a high-protein, high-energy (both DCP and TDN are about 120% of the NRC standard) or medium-protein, medium-energy (about 100% of the NRC standard) diet, while it was bad when animals were nourished with a diet ill-balanced between the amounts of protein and energy.[7]

In the experiment an outline of which is dealt with in this paper, the author used 43 non-pregnant milk-secreting Holstein cows and 19 bulls of the same variety as experimental animals to divide into 24 diet groups, which were set up by various combinations of DCP (30~330%) with TDN (60~140%) on the basis of the NRC standard.

The animals were fed on these different diets from 6 to 12 months, during which time they were subjected to periodical examinations as clinical, biochemical, hematological and reproductive observations as well as milk yield, milk quality and semen test, at intervals of 1 to 2 weeks, and sacrificed at the end of the feeding experiment for autoptical and histopathological observations.

NRC standard and changes observed in cows

1) Clinical observation

In high-protein, medium to high-energy groups (DCP 150~330%, TDN 100~140%), the cows showed increases in body weight and milk yield. Diarrhoea and loose passage were observed to occur, though the hair was glossy. The congestion of eye conjunctiva appeared 2 to 3 months after the beginning of the feeding. Animals fed with much amounts of concentrate lost their appetite within 1 to 2 weeks and recovered it if some feed rich in fiber, as rice straw, was given at a rate of 1 kg a day. This amount of fiber corresponded to about 10% of the total amount of feed given.

In the low-protein, low-energy groups (DCP 30~80%, TDN 50~80%), the results were contrary to those obtained in the above-mentioned groups, showing decreases in body weight and milk yield, *coarse hair* as well as remarkable atrophy of the abdomen and udders.

Hypothermia and an increase in the daily difference of the body temperature were also observed. Animals became sensitive to infectious diseases because of lowered vital resistance of the body.

The symptoms manifested by animals in the high-protein, low-energy groups resemble those observed in the low-protein, low-energy groups, becoming less remarkable with the increase of energy contained in the diet. There was a tendency that the nutrition of domestic animals was considered centering around protein up to this time, but these results suggest importance of energy sources coming from feed.

2) Hematological observation

There was no animal which manifested remarkable hematological changes, but some showed a small decrease in the number of red blood corpuscles after 4 to 6 months' feeding in both the high and low-protein groups. While the mean volume of red blood corpuscles was 44.1~49.3 μ^3 in the animals in normal feeding, it was 52.4~54.4 μ^3 in these abnormal cases, showing a slight increase in the volume.

3) Clinical observation from the viewpoint of reproduction

As shown in Table 2, the ovarian cyst, ovarian dysfunction, silent heat, irregularity of oestrous cycle, luteal cyst, persistent corpus luteum and incomplete absorption of liquid in corpus luteum were observed in females, though their occurrence was rare in the medium-protein groups (DCP 95~130%, TDN 100~120%).

The ovarian cyst and ovarian dysfunction were frequent in the high and low-protein groups, respectively. And in the case of low

Table 2. Reproductive observation

Feeding	Item							
	No. of animals used	Ovarian cyst	Ovarian dysfunction	Silent heat, irregularity of oestrous cycle	Luteal cyst, persistent corpus luteum	Incomplete absorption of liquid in corpus luteum	Abnormal	Normal
Female								
High protein	13	4	3	3			10	3
Medium protein	11			2		1	3	8
Low protein	19	4	4	3	2		11	8
Male								
High protein	6	Lowering of semen quality 4					4	2
Medium protein	5						0	5
Low protein	8	Lowering of semen quality 8					8	0

energy, animals in both of these groups often showed the occurrence of ovarian dysfunction.

In males, many individuals of the high-protein groups showed abnormalities in the number and motility of sperms as well as high ratio of abnormal sperms. They also showed the worsening of general characters of the semen such as a decrease in fructose content, in comparison with the control. These changes tended to become remarkable in both low-protein and low-energy feedings.

4) Biochemical observation

(1) Changes of the components of blood and urine

The blood components which showed remarkable changes were protein relatives, such as protein, non-protein nitrogen (NPN) and urea as well as albumin-globulin ratio (A/G ratio). The increase of serum protein and urea, and the decrease in A/G ratio were observed in the high-protein groups, while the changes reverse to this appeared in the low-protein groups. Carbohydrates, lipids, intermediary metabolic substances and inorganic components showed no remarkable difference between the high and low-protein groups.

The qualitative test did not show any noticeable difference between the high and low-protein groups in the amounts of urine components, but the pH of urine was apt to be acidic in animals fed on high-phosphorus, low-calcium feed.

The lactose content of urine was proved to be more than 30% in the milk-secreting cows. However, such a high percentage of lactose is not a pathologic condition because it has been reported that lactose was detected in the urine when the inner pressure of udders reached more than 15 mm Hg.[4] The fact that the lactose synthesized in the mammary gland is excreted from the body means a nutritional loss, the prevention of which is important.

Preventive measure has not yet been completed to prevent the loss.

(2) Changes of milk components

The changes of milk components in different feeding regimes are shown in Table 3. The milk yield showed an increase in the high-protein, high-energy groups, but the fat percentage tended to decrease in them. These changes had a tendency to be opposite to the above in direction in the low-protein, low-energy groups. The quality of milk examined on the basis of pH, specific gravity, fat level and alcohol test was abnormal in few animals in the medium-protein, medium-energy groups, but these abnormalities were observed in many individuals in both the high-and low-protein groups.

5) Autoptical observation

All the test animals, 62 in total, in the 24 diet groups were sacrificed after the 6 to 12

Table 3. The changes of milk component in various feeding regimes

DCP	TDN			
	High energy 120~130%	Medium energy 100~120%	Low energy 50~80%	Milk component
High protein 150~330%	tendency of increase	This group shows the same tendency to high-protein high calorie group	decrease	milk yield
	increase		〃	total fat
	tendency of decrease		tendency of increase	fat percentage
	increase		no change	protein
	no change		〃	lactose
	tendency of increase		〃	solid not-fat
	increase		increase	NPN
	increase		〃	urea N
Medium protein 95~125%		no change		milk yield
		〃		total fat
		〃		fat percentage
		〃		protein
		〃		lactose
		〃		solid not-fat
		22~26 mg/dl		NPN
		13~15 mg/dl		urea N
Low protein 30~80%	decrease		decrease	milk yield
	〃		〃	total fat
	tendency of increase		tendency of increase	fat percentage
	increase or decrease		decrease	protein
	no change		〃	lactose
	little decrease		〃	solid not-fat
	〃		decrease→increase	NPN
	〃		〃	urea N

months' feeding experiment to examine autoptically.

Practically no abnormal change was observed in the medium-protein, medium-energy groups, while various changes were found in both high and low-protein groups. Though detailed descriptions are impossible to be made in this paper, the changes in the high-protein, low-energy groups resembled those in low-protein groups, showing that the results almost corresponded to those of clinical observations.

A characteristic change observed in the high-protein, high-energy groups was the incomplete deposition of black coloring matter in the mucosal membrane extending from the rumen to omasum as shown in Fig. 1. In such a case, the rumen wall becomes thin and healing is retarded when it is injured, accompanied by dysfunctions of the rumen.

Significance of urea in the blood and milk

The above description has been made on the nature of the abnormal changes occurring in cows fed on diets in which the amounts of protein and energy were out of proportion as compared with the NRC standard, showing that the changes were remarkable in animals of high-protein, low-energy groups. Therefore, if there is any method to judge whether

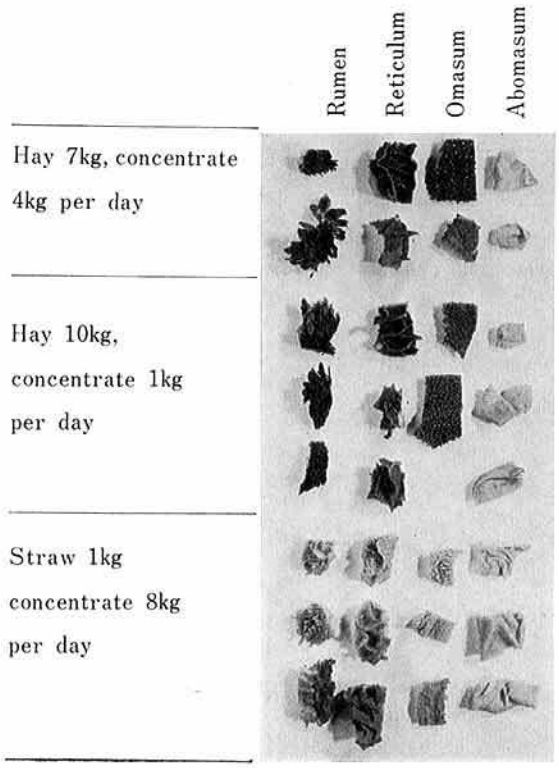


Fig. 1. The change of deposition of black coloring matter in mucosal membrane of rumen by various feedings.

cows are on a high protein diet or not by the examination of their blood, it can be an indicator to know their nutritional condition.

As a result of various experiments, it was found that the amount of urea in the serum and milk was nearly parallel to the protein intake if TDN is more than 80% as compared with the NRC feeding standard.[1), 5)]

In case cows are fed mainly on Tofu-cake, the protein of Tofu-cake eaten, is decomposed to ammonia by microorganisms living in the rumen and absorbed through the rumen wall, causing an unexpected increase in the amount of urea. But the increase is nearly parallel to protein intake when cows are fed on a usual diet.

In Table 4 which shows the results of examinations of farmers' cows, the amount of urea nitrogen is 13 to 15 mg/dl in both serum and milk of cows on diets based on the NRC feeding standard. In the cases showing more than 20 mg/dl of urea, the excess of protein intake must be considered.

As to the rapid method of urea nitrogen determination,[3)] the unigraph method was compared with the diacetyl monoxime method, obtaining well coincident results between the two methods. The unigraph method can be easily applied to examinations in the field.

Criteria for the diagnosis of nutritional condition in cows

The nutritional disorders of cows occur from both causes of feeding and animals and very complex in the nature. To clarify the subject, it is necessary, as the first step, to make criteria for the diagnosis of nutritional conditions of cows. Consequently, cooperative investigations of the criteria have been carried out by the National Institute of Animal Health. Tōhoku branch of the same institute and Tōhoku University since 1957 on the basis of the experiments on the occurrence of nutritional disorders, studies on the rumen fermentation and researches on the actual

Table 4. The relation between urea in blood, milk and protein intakes on farmer's cows

Total digestible nutrients (TDN)	Digestible crude protein (DCP)	Blood		Milk		No. of animals
		NPN	urea N	NPN	urea N	
95%<	> 95%	22.0	12.0	24.5	12.0	2
	96~130%	24.8	15.1	23.8	14.5	18
	131~150%	28.5	16.5	30.6	18.1	12
	151%<	32.2	19.5	34.8	22.1	18

Remarks; unit mg/dl
NPN ... Non-protein nitrogen

Table 5. Criteria for the diagnosis of nutritional condition in cows

Most important component	Next important Component	Normal range	Method
No. of erythrocyte		550~700 million/cm³	Thoma-Zeiss or Hematocrit method
Hemoglobin		60~70 %	Sahli method
Serum protein		6.0~7.5%	Refractometer
Serum albumin		2.8~3.8%	Biuret method
Serum urea		15~17 mg/dl	Unigraph method
Vitamin A in blood		50 IU/dl	Fujita's method
Rumen juice fermentation		20%<	Fermentive tube method
Ketone body in urine		negative	Sino-test No. 3
milk			
Alcohol test		negative	70% alcohol
Specific gravity		1.030<	Lactodensimeter
pH		6.2~6.6	M.R. test paper
milk	Protein	3.0%<	Micro-Kjeldahl method
	Urea	15~20 mg/dl	Unigraph method
		Hayem's solution	
	Liver function	2.0~4.0 ml.	Gross reaction
		serum 1 ml.	
	Bone hardness	13 kg<	Toba's scale

conditions in the field. After several revisions were made in conjunction with the progress of studies, the final decision was published in 1962 as shown in Table 5. These are the criteria for milk-secreting cows in the pregnancy of 6 to 7 months or less, and may possibly be revised with the progress of analysis of the environmental conditions of rearing, etc. in future.

The details of the criteria were published in *Results of Researches* 3-1[2] and 20[6] of the Agriculture, Forestry and Fisheries Research Council.

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