A Thesis

For the Degree of Doctor of Philosophy

Effects of Specified Feed and Feeding Program on Economical Farming of Jeju Crossbred Horse

Jae-Ho Bae

Department of Biotechnology

GRADUATE SCHOOL

JEJU NATIONAL UNIVERSITY

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Jae-Ho Bae

(Supervised by professor Min-Soo Kang)

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This thesis has been examined and approved by

Thesis director, Professor Kyu-Kye Hwang, Ph. D. D.V.M. College of Veterinary Medicine, Jeju National University

Professor Han-Jong Ko, Ph. D. Department of Agricultural Science, Korea National Open University

Expert member Tae-Jun Kwon, Ph. D. College of Applied Life Science, Jeju National University

Expert member , Kyong-Leek Jeon, Ph. D. College of Veterinary Medicine, Jeju National University

Professor Min-Soo Kang, Ph. D. College of Applied Life Science, Jeju National University

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ABSTRACT

The present study was conducted to examine the effects of the application of dedicated feed on fattening horses. The purpose of the study was to investigate the effects of feed developed for fattening horses and riding horses to enhance their productivity. The body weights, body types, feed intakes of were measured. and blood and serum analyses were conducted on eight fattening horses in the experimental group and eight fattening horses in the control group.

□ Questionnaire survey

Halla horse (Jeju Crossbred horse)

According to the results of the questionnaire survey about Halla horses, 65%, 25%, and 10% of the feed were purchased from the National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm, and the remaining 25% was produced in - house. The daily feed rations were as follows: 8 kg for each fattening horse, 2.5 kg for each growing horse (6 - 12 months), 3.5 kg for each growing horse (13 - 24 months), and 3.5 kg for each adult horse (at least 24 months). Roughage was freely provided.

□ Investigation of the body types of the fattening horses

The measurements of the fattening horses in the experimental group showed that the chest width significantly increased to 58 ± 2.5 cm * (*, $p < 0.05$) at the last measurement. The chest girth increased to 181 ± 1.58 cm * (*, $p < 0.05$), and chest

depth to 44 ± 0.82 kg (*, p <0.05). These results indicate that the upper part of the belly gained the greatest amount of weight. With regard to overall weight changes, the experimental group showed a significant increase from 265 ± 18.52 kg at the beginning of the experiment to 322 ± 27.42 kg ** (**, p <0.01) at the last measurement. The changes in the body types of the fattening horses during the experimental period were examined. According to the results, although there was no increase in regions related to increases in the entire skeleton, changes following increases in weight were observed. In particular, body weight showed a tendency to increase significantly compared to the control group. Hence, the efficiency of the feed provided to the experimental group was greater than the feed provided to the control group.

□ Blood and serum tests

In the fattening horses, AST increased to 319 ± 106.1 U/I * (*, p <0.05) compared to the beginning of the experiment, and ALT significantly increased to 18 ± 8.2 U/I * (*, p <0.05). In the control group, AST significantly increased to 144.2 ± 18.2 U/I and ALT significantly increased to 9 ± 2.4 U/I * (*, p <0.05). No other item significantly increased or decreased. Similar to riding horses, AST and ALT increased in the fattening horses. The reasons are considered similar to those in riding horses. Compared to riding horses, AST and ALT values were measured as higher in the fattening horses during the experimental period. These results indicate that the riding horses performed the defined exercises after the dedicated feed was provided. The fattening horses exercised less compared to the riding horses because they were confined to their stalls. Hence, the repeated storage and utilization of energy continued in the fattening horses leading to increases in the role of the liver.

The objectives of the present study were to develop and supply systematic feeding programs based on the nutritional requirements of individual

horses according to the ages and weights of horses being raised in South Korea. Quantities of nutrients were recommended according to growth period after birth, the ratio between crude feed and concentrated feed, and the kinds of feed in order to enable efficient feeding and to minimize the economic losses caused by improper nutrition.

□ Growing horse and brood mare body type investigation

A. Growing horse

The body types of The growing horses were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. During the experimental period, changes were observed in the body length, withers height, back height, croup height, chest width, chest girth, chest depth, croup length, head length, Antebrachium length, and the body weight. These tendencies were shown to be similar in both the experimental group and the control group of growing horses. All items investigated showed the tendency to increas.

B. Brood mare

The body types of the brood mares were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. Slight changes appeared during the experimental period in the body length, withers height, back height, croup height, chest width, chest girth, chest depth, croup length, head length, Antebrachium length, and the body weight.

The changes in the body types of the growing horses and the brood mares that resulted from changes in the feed rations were examined. According to the results, the

growing horses clearly showed increases in values because they were in the phase of the highest growth. However, in the brood mares, no changes in body type resulted from changes in feed rations during the experiment period.

□ Blood and serum tests

The results of blood tests were examined. The blood cells in whole blood were analyzed to examine the following items; WBC, LY, MO, GRAN, LY, RBC, Hb, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, PDW, and PCT. The results of the serum chemical test for TP, ALB, AST, ALT, GGT, ALP, GLU, T - BILL, NH, TG, TCHO, LDH, BUN, CREA, IP, Ca, AMYL, Lip, Mg, and UA were examined. No differences in value were found between the experimental group and the control group. In addition, all values were with in the normal range. No clinicopathologic findings were apparent in the results. Hence, no changes in enzyme and metabolism related values resulted from the changes in feed rations.

Therefore, the daily feed rations were 8 kg for a fattening horse, 2.5 kg for a growing horse (6 - 12 months), 3.5 kg for an older growing horse (13 - 24 months), 3.5 kg for an adult horse (at least 24 months). The results of the present study showed that the most efficient feed rations were as follows: adult horse, 3.5 kg; 3 ~ 4 month - old horse 1.5kg, 4 ~ 5 month - old horse, 2 kg; 5 ~ 6 month - old horse, 2 kg; 6 ~ 7month - old horse, 2.5 kg. Further studies hould be conducted to develop and supply systematic feeding programs based on the nutrients required by individual horses according to the age and weight of horses being raised in South Korea. Quantities of nutrients should be recommended according to growth period after birth, the ratio between crude feed and concentrated feed, and the kinds of feed in order to enable efficient feeding and to minimize the economic losses caused by improper nutrition.

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CHAPTER 1

ABSTRACT

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According to the results of the questionnaire survey about Halla horses, 65%, 25%, and 10% of the feed were purchased from the National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm, and the remaining 25% was produced in - house. The daily feed rations were as follows: 8 kg for each fattening horse, 2.5 kg for each growing horse (6 - 12 months), 3.5 kg for each growing horse (13 - 24 months), and 3.5 kg for each adult horse (at least 24 months). Roughage was freely provided.

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In the fattening horses, AST increased to 319 ± 106.1 U/I * (*, $p < 0.05$) compared to the beginning of the experiment, and ALT significantly increased to 18 ± 8.2 U/I * (*, $p < 0.05$). In the control group, AST significantly increased to 144.2 ± 18.2 U/I and ALT significantly increased to 9 ± 2.4 U/I * (*, $p < 0.05$). No other item significantly increased or decreased. Similar to riding horses, AST and ALT increased in the fattening horses. The reasons are considered similar to those in riding horses. Compared to riding horses, AST and ALT values were measured as higher in the fattening horses during the experimental period. These results indicate that the riding horses performed the defined exercises after the dedicated feed was provided. The fattening horses exercised less compared to the riding horses because they were confined to their stalls. Hence, the repeated storage and utilization of energy continued in the fattening horses leading to increases in the role of the liver.

Introduction

Horses have been our companions and have worked beside us for many centuries. In agriculture, horses have played central roles in farming, load transportation, and riding. However, with increased economic development, their uses have changed greatly, Recently, utilization of horses the has expanded into the areas of leisure sports and tourism such as horseracing, horseback riding, and trick riding.

The central and local governments have become increasingly interested in the horse business. In the wake of the well-being culture, people's interest in the riding horse and fattening horse industries has grown. The scale of breeding has also increased. The interest in the horse industry, which formerly was concentrated on only the racehorse production and horse racing industries, has gradually expanded to related industries, such as the horse riding industry and the horse meat industry.

Horse meat contains large quantities of functional unsaturated fatty acids. In particular, it contains 2 ~ 3 times more palmitoleic acid and omega-3, which are classified as functional substances compared to other kinds of meat. Palmitoleic acid has been reported as a substance that reduces blood cholesterol content and enhances pancreatic functions. In addition, palmitoleic acid is a major component of sebum, which protects human skin by performing powerful antibacterial functions. In Japan and Korea, folk remedies have long used horse oil as a skin protectants in atopy and burn healing. The efficacy of horse oil is attribut to the large quantity of palmitoleic acid that it contains (Lee, 2006). Most Koreans prefer the tastes of meat only when it contains an appropriate amount of fat. Moreover, the Korean meat grading system gives the highest ratings to meat thats is

highly marbled. Hence, marbling scores are directly related to farm incomes. In general, horsemeat is less preferred because its fat contents is lower compared to other meat (Yu et al., 1993). Therefore, enhancing the marbling scores of horsemeat to improve its quality is regarded as an important element in the expansion of horsemeat consumption (Lee et al., 2003). Lee et al. (2006) advised that during the preliminary feeding experiment period (18 ~ 24 months), no difference in daily gains (0.39 kg vs 0.38 kg) was shown between the castrated group and the non - castrated group and that even before the preliminary experimental feeding period, there was no significant difference in daily gains or feed intake between the castrated group and the non - castrated group or between the control group and the low - calcium feed group. They also reported that although the carcass percentages did not significantly differ according to feed type or castration, the castrated group showed a tendency to yield higher carcass percentages compared to the non - castrated group. Furthermore although back - fat thicknesses did not different between treatments, eye muscle cross sectional areas were shown to be larger in the castrated group compared to the non - castrated group. In addition, regarding the contents of the crude components of the eye muscle, although the content of crude fat was shown to be higher in the castrated group compared to the non - castrated group, the contents of crude protein, crude ash, and so on did not significantly differ between treatments. The water holding capacity, heating loss, shear force, pH, and meat color of THE eye muscle samples DID not differ according to feed type or castration, However, according to the results of the sensory evaluation, the flavor and comprehensive evaluation were shown to be significantly higher in the castrated group compared to the non - castrated group. Although softness and juiciness did not significantly differ, the castrated group showed a tendency to have improved softness and juiciness compared to the non - castrated group.

In the case of Japan, chunks that have the capacity to reach 1,000 kg ~ 1,200 kg in weight at the completion of fattening and good meat quality such as marbling are used for consumption. These chunks are favorably received by both farms and consumers because their growth rates, carcass ratios, and fresh meat percentages are excellent and the qualiy of the meat is good. Because the market is now consumer oriented the horsemeat industry will continue to grow only if high quality horsemeat is available. If horse farming were carried out to produce horsemeat and not racehorses , the popularization of horsemeat might be accelerated (Lee, 2006).

To review the number of horses being raised throughout the world, the ratio of race horses to the entire number of horses is low except in traditional racehorse production in some countries (e.g., the UK, Australia, New Zealand, Ireland, Japan, etc.) Riding horses account for at least 90% of all horses being raised in most countries. In this situation, the horse riding industry in advanced foreign countries can be largely divided into three patterns: first, the horse riding industry developed based on producing traditional riding horses; second, the horse riding industry developed based on racehorses until the latter were retired and converted into riding horses; and third, the horse riding industry developed by producing ponies that are mostly native breeds (Kim et al., 2011). To review the situation of riding horses in South Korea, as of July 2008, 190 horse - riding courses were in business and 4,494 riding horses were registered (Korea Racing Authority, 2008). Most riding horses were retired racehorses and were tamed before being used. However, insufficient progress was made in the production and fostering of horses dedicated to horse riding. Although the horse riding population was increasing, instead buying, managing, and feeding their horses, individual horse riders used horses that belong to horse - riding courses in almost all cases. Unlike fattening horses or racehorses, riding horses have several distinctive characteristics, such as the ability to maintain intense and

persistent exercise and keep time with the rider.

Therefore, the present study was conducted to examine the effects of the application of dedicated feed in fattening horses and in producing riding horses. The aim is to increase the productivity of horse farms by investigating the weight, body type, feed intake, and blood status of the horses used in the experiments performed in this study.

LITERATURE REVIEW

- Horse Behavior -

Many studies have been conducted on the behavior of horses. Major studies include the following: [“‘The numbers of heads of horses constituting harems in natural environments” (Waring, 1983); “Auditory areas of horses and humans” (Hwggner, 1983); “Combinations of figures used in horses’ learning experiments” (Dixon, 1970); “Distribution of nursing times” (Kusunoseet al., 1984); “Changes in foals’ play partners” (Kusunoseet al., 1984).] ‘the grazing behaviors of improved horses, the Welsh pony, the Newforest pony, and the wild pony; the eating habits, feed intake, and water consumption of female horses and male horses (Tyler, 1972 ; Hltmann, 1974 ; Ralston and Baile, 1982 ; RowellDavisetal, 1985) Other studies investigated the feed intake, grazing, and breeding behaviors of the traditional Japanese horse, the Mokjeung (Tsujii and Asai, 1985a, 1985b, 1986; Tsujii and Moro, 1987; Tsujii and Hisamori, 1990).

Waring (1983) reported that the size of a harem ranged from 2 ~ 21 head. The average harem size varied according to the size of the region inhabited and the habitat density. The variations in the average number of horses that constituted a harem was observed to ranging from 3.2 to 12.3 head.

Mimura (1997) reported that the period for a stallion to belong to a harem was 2 ~ 3 years on average. However, in some cases the period was 10 years or longer. In addition, although adult female horses belonged to the

same harem for their lifetime, female horses born in a harem generally left it in 2 ~ 3 years. Many female horses voluntarily left their harem before they became two years old, or they were expelled by other adult female horses before finally joining another harem.

Heffiner (1983) reported that unlike humans, horses'auditory threshold tended toward the upper register was almost 36 Khz. Mimura (1997) reported that to some extent horses could identify individual horses by their crying sounds and that it was empirically known that horses could identify human sounds and environmental sounds.

Dixon (1970) conducted a figure discrimination learning experiment with horses by using 20 combinations of figures. Mimura (1997) reported that he continued the Dixon's experiment for 87 successive days. The horses' responses were correct 92.5% of the time. He then examined the progress in loss of memory one month, three months, and six months after the learning experiment. The results showed that the percentages of correct responses obtained one month, three months, and six months later were 80%, 78%, and 77.5% respectively. During this experiment, the horses were shown to discriminate new combinations of figures faster as the learning progressed, which was strong evidence that the horses had the ability to learn the general rules of the tasks given to them.

Kusunos et al. (1984) stated that in addition to taming by humans, changes in horses' behaviors which were considered the results of learning were recognized in their natural activities. For instance, although mother horses' nursing time for their foals changed little as their parity increased, a tendency towards variations was recognized at lower parity.

Mimura (1997) advised that changes in abnormal behavior were probably attributable to mother horses' learning. Scream manipulation was implemented in the training of racehorses to accustom them to the crowd noises at racecourses and to expose them to new and strange environments. On the day of the race, stress is reduced as much as possible so that the racehorse can sufficiently exert its ability, which could be said to be an example of horses' ability to learn.

- Horse nutrition -

Kohnke (1999) and Clarke et al. (1990) reported that the pH was lowered because the excessive provision of cereals increased the secretion of endotoxins by microorganisms and might cause colic or lamunitis.

Collins (1988) reported that the proteins are mainly concentrated in the leaves of vegetative tissues. They exist at much lower levels on stems. Alfalfa and timothy leaves contain 2 ~ 3 times more proteins compared to their stems.

Green et al. (1971) reported that the protein content in herbage varies greatly in varieties and environments. Growth stages severely affect the protein content of herbage, and the protein levels decrease as the plant grows.

Givens et al. (1992) reported that as herbage matures, more stems are produced so that the ratios of cellulose and lignin increase, the ratio of hemicellulose decreases, and digestibility decreases with the passing of seasons.

Miller (1984) reported that the degree of absorption of minerals by herbage from soil varied with the pH of soil, water content and grass species. In addition, and that the utilizability of P, K, S, Ca and Mg was high at soil pH 6.5 ~ 7.5 and the utilizability of Fe, Mn, Zn, and Cu was high at soil pH 5 ~ 6.

Lee et al. (2007) reported that the pH of volcanic ash soils in farms in the entire Jeju region showed an acidity of approximately 5.0.

Mc Meniman (2003) reported that the digestibility of the dry matter of blue grasses/alfalfa grasslands by horses was 73% in young grazing grasslands with a plant length of 11cm and 52% in grasslands, Mature herbage had a plant length of 47cm and higher ratios of stems than young herbage.

Menard et al. (2002) reported that the dry matter digestibility of medium quality semi-natural grasslands was 61% in May and 53% in July.

Sauvant and Van Milgen (1995) reported that synchronization in the rumen could be induced by changes in the composition of carbohydrates and proteins in feed or by changes in the method of feeding.

Kalscheur et al. (1999) reported that metabolic proteins could be regarded as the sum of the microorganism proteins that are synthesized in the rumen and flow into the small intestine and the by-pass proteins did not decompose in the rumen.

Byers and Moxon (1980) reported that the meat productivity of fattening cattle was greatly affected by the levels of nutrients in the feeds

provided in the fattening stage. Accordingly, when the level of crude protein was raised in the growth period and in the early fattening period, dressed carcass weight, eye muscle cross sectional areas, and marbling scores increased. Rossi (2000), Perry (1983), and Martin et al. (1979) reported that in such cases, back-fat thicknesses decreased remarkably while weight gain and feed conversion rates improved.

Chae et al. (2014) reported that most of the horsemeat distributed in South Korea was not from professionally fattened horses but from horses that had been raised for races or production before being judged unsuitable. They were fattened within a short period.

Nongchon jinheung (2012) reported that approximately 50% of 150,000 tons of citrus fruits used for the production of citrus fruit beverages were scrapped as waste. Because of its potential as an immune booster, he used this waste as a by product in pig feed, which would enhance the resistance of pigs to disease.

In a study of the growth characteristics of fattening horses provided with TMR feed made by mixing distillers' dried grains into wet citrus wastes, Lee et al. (2012) reported that when the TMR feed was provided, the rate of gain was higher than when only citrus wastes were utilized.

Jung (2009) reported that horse fattening tests were conducted using feed made by mixing wet citrus wastes with mushroom media. According to the results, the group provided with citrus waste mixed with mushroom media showed increases in daily gains compared to the group provided with only citrus fruit grains.

Chae et al. (2014) reported that when wheat bran and dry citrus waste were provided to an approximately 24-month old Jeju mountain horse group for five months, the mean weight increased from 272.8 kg to 334.4 kg (Chaeet al., 2013). A treatment group of 24-month old Jeju mountain horses provided with commercial concentrated feed for four months showed a mean weight of 330.8 kg, which was similar to the results obtained with agricultural by-product feed indicating that the nutrient balance in the commercial concentrated feed was excellent.

Chae et al. (2014) reported that the daily gains of fattening horses fed with commercial concentrated feed decreased as the fattening age increased. The horses were 0.46 kg at a fattening period of four months, 0.39 kg at eight months, and 0.34 kg at 13.5 months. In addition, daily gains in the two-month units were 0.25 kg in 0 ~ 2months, 0.74 kg in 3 ~ 4 months, 0.28 kg in 5 ~ 6months, 0.20 kg in 7 ~ 8 months, 0.30 kg in 9 ~ 10 months, and 0.31 kg in 11 ~ 13.5 months. The highest daily gain occurred in the 3 ~ 4 month fattening period.

Jung et al. (2010) reported that when 24 - month old Jeju crossbred horses with an initial body weight of 321.5 kg were provided with a mixture of citrus waste and concentrated feed for three months and six months, the body weight after fattening for three months of the group fed with the mixture of citrus waste and concentrated feed was 371.3 kg indicating a daily gain of 0.55 kg.

Chae et al. (2014) reported that feed intakes over the fattening period were 4.30 ~ 4.41 kg for 0 ~ 2 months of fattening, 4.55 ~ 4.61 kg for 3 ~ 4 months of fattening, 5.56 ~ 5.64 kg for 7 ~ 8 months of fattening, 5.76 kg for 9 ~10 months of fattening, and 6.03 kg for 11 ~ 13.5 months of

fattening. Daily feed in takes per head increased as the fattening periods in creased. The daily in takes were 4.42 kg in the group treated with fattening for four months, 5.00 kg in the group treated with fattening for eight months, and 5.26 kg in the group treated with fattening for 13.5 months.

Jung et al. (2010) reported that when 24 - month old Jeju crossbred horses were provided with a mixture of citrus waste and concentrated feed, the feed conversion rates were 15.1% for 0 ~ 3 months of fattening and 16.1% for 4 ~ 6 months of fattening.

Chae et al. (2014) reported that when feed conversion rates over fattening periods were examined in units of two months, the lowest feed conversion rate was at 3 ~4 months. The feed conversion rates were 14.99% at 0 ~ 2 months, 6.14% 3 ~ 4 months, 20.41% at 5 ~ 6 months, 29.96% at 7 ~ 8 months, 20.11% at 9 ~ 10 months, and 19.55% at 11 ~ 13.5 months.

Lee et al. (2005) reported that when male Jeju horses were fattened, daily gains and feed intakes did not differ between the castrated group and the non - castrated group. eye muscle cross-sectional areas increased a little more in the castrated group, and marbling scores showed a tendency to be improved by castration although there was no significant difference. The crude fat content in the horsemeat eye muscle increased, whereas the contents of crude ash and crude protein showed a tendency to decrease.

Before starting this study, participants from the Jeju Equestrian Club were surveyed regarding the status of the province. Equestrian identify and report on-site and made to identify the relevant studies and basic data was intended to take advantage of. They were asked about how horses were fed, and daily feeding accounted for 43% of the results and 4 - 6 kg of limited

feeding accounted for about 40%. This means that about 83% were self - pay, or 4 - 6 kg, confirming that the main use of the company has shown that the Nong-hyup (kwon, 2014).

Studies on horsemeat were mainly conducted in European countries. The major studies include the following topics: meat characteristics (Palenik and Belchova, 1978; Martin - Rossetet al., 1980; Catalano et al., 1986; Lacheretzet al., 1990; Manfrediniet al., 1992; Badianiet al., 1993; Campodoniet al., 1994); nutritive components(Catalano and Quarantelli, 1979; Paleniket al., 1980; Badianiet al., 1997); carcass characteristics(Moczybroda, 1976; Rossier and Berger, 1988); storage characteristics(Roth et al., 1995); handling before butchery(Stull, 2001); and processing characteristics (Perez et al., 1998; Paleariet al., 2002; Paleariet al., 2003).

MATERIALS AND METHODS

1. Test period and animals

In the present study, field questionnaire surveys and field feeding experiments were conducted for a period of three months from August to November 2012. The field questionnaire surveys centering on farms that were breeding in a certain sale not smaller than 20 heads among clients of Agricultural Cooperative Federation Feed in Jeju - do separately for Jeju Native horse, Halla horse (Jeju crossbred horse), and Thoroughbred farms and the field feeding experiments were conducted for three months separately for fattening horses.

Among the experimental animals used in the present test, were 16 head of fattening horses elected from dedicated horsr-fattening farms located in Aewol - eup, Jeju -si, and Jeju - do. The fattening horses used in the test were Jeju crossbreed horses. The mean weight of the experimental group of fattening horses was 265 ± 18.52 kg and that of the control group was 315 ± 18.52 kg.

2. Experimental group assignment

The 16 horses were divided into two treatment groups: the experimental group and the control group. The horses were assigned using completely randomized block design methods that considered the weights.

The fattening horses in the control group were fed on a horse - fattening farm in Aewol - eup, Jeju - si using the National Agricultural

Cooperative Federation feed for Jeoktoma (bred horse), which is identical to the feeding method used for conventionally raised fattening horses.

The fattening horses in the experimental group were provided with the feed developed as a dedicated feed for fattening horses twice a day, once in the morning and once in the afternoon per each horse.

3. Feeding management and provided feed

The feeding of the fattening horses was based on the conventional feeding management of the horse - fattening farm in Aewol - eup, Jeju - si. After assigning the experimental groups, the horses were accommodated in a small barn that provided a 2 × 3 stall for each horse.

Assorted feed an droughage were provided to the feeding tanks installed in the stalls. Feed intakes and residual quantities were examined in each stall. Concentrated feed was given at 10:00 hours and 20:00 hours every day. Hay was freely given as roughage. The litter in each stall was a mixture of chaff and sawdust to athickness of approximately 10 cm. Water was freely provided in a water bucket in each stall.

4. Investigation items

A. Fattening horse body type investigation test

The feed was provided to the experimental group and the control group of fattening horses during the experimental period. The body length, body height, back height, hip height, chest width, chest circumference, chest depth, hip length, head length, foreleg length, and body weight of each horse were measured four times at intervals of one month. The intakes of the feed were investigated in every stall. The residual amounts from the feed provided were measured every day to determine intakes, which were divided by the number of horses to determine the intake of an individual horse. All results obtained through the present experiment were examined using the analysis of variance of SAS (2002). The significance of the results was determined by using t - tests.

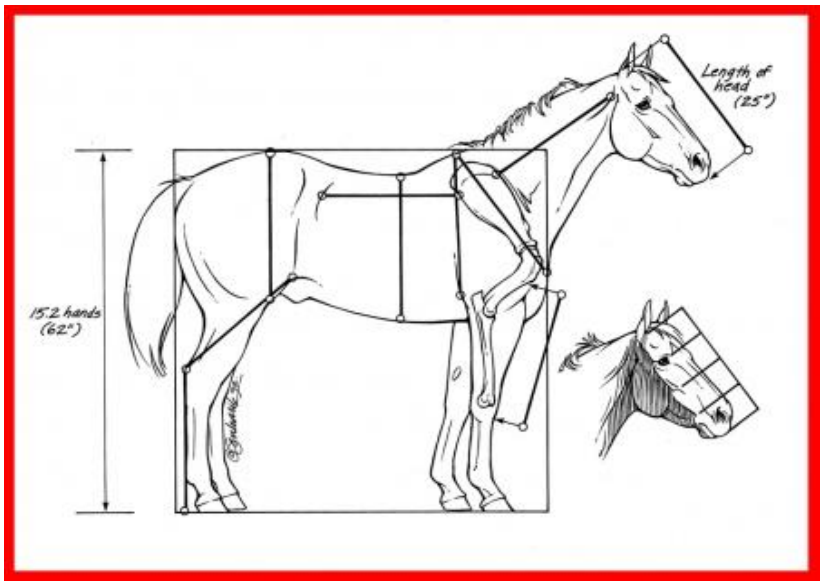

Figure 1.1. Method of investigate in measurement Jeju crossbred horse.

Figure 1.2. Collected experiment sample pictures of fattening horse.

B. Fattening horse blood test and serum test

◆ The experimental group and the control group of fattening horses were provided with their respective feed. Blood was collected four times from the cephalic vein using 10 ml syringes at intervals of one month. To analyze the hematological findings from the collected blood, some of the blood was treated with EDTA. The remaining blood was centrifugd and the serum was

collected. The serum was kept frozen until it was analyzed. The blood and serum were chemically analyzed as follows: red blood cells (RBC) and white blood cells (WBC) were counted in the standard clinical hematological method. Thereafter, the packed cell volume (PCV) was measured using the micro - hematocrit through centrifugation at 12,000 rpm for five minutes. In addition, Hb values were obtained by measuring the optical density at 540 nm using the cyan hemoglobin method. The mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) values were obtained using the standard clinical hematological method. In addition, the total protein, albumin, aspartate aminotrans-ferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), creatinine, glucose, bilirubin, LDH, calcium, inorganic phosphorus (IP), and magnesium's serum chemical items were analyzed using an automatic serum chemical analyzer (Pronto evolution; BPC Biosed, Italy). The reagents used were from the Asan Pharmaceutical Co. (Korea). The tests sent to the Jeju Special Self - Governing Province Veterinary Service Laboratory for analysis.

RESULTS AND DISCUSSION

1. Questionnaire survey

A. Jeju Native horse

According to the results of the questionnaire surveys about the Jeju Native horses, 75%, 15%, and 10% of the feed were purchased from the National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm; and the remaining 25% was produced in - house. Daily feed rations were 6 kg for each fattening horse, 2 kg for each growing horse (6 - 12 months old), 3 kg for each growing horse (13 - 24 months old), and 3 kg for each adult horse (at least 24 months old). Roughage was freely provided.

B. Halla horse (Jeju Crossberd horse)

According to the results of questionnaire surveys about the Halla horses, 65%, 25%, and 10% of the feed were bought from the National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm; and the remaining 25% was produced in-house. Daily feed rations were 8 kg for each fattening horse, 2.5 kg for each growing horse (6 - 12 months old), 3.5 kg for each growing horse (13 - 24 months old), and 3.5 kg for each adult horse (at least 24 months old). Roughage was freely provided.

C. Thoroughbred

According to the results of questionnaire surveys about the Thoroughbred horses, 10%, 75%, and 15% of the feed were bought from National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm; and the remaining 25% was produced in-house. Daily feed rations were 3.5 kg for each growing horse (6 - 12 months old), 6 kg for each growing horse (13 - 24months old), and 6 kg for each adult horse (at least 24 months old). Roughage was freely provided.

2. Body type investigation and test

The body types of fattening horses were investigated during the experimental period. The differences between the horses in the experimental group and the control group were examined. Among the criteria that indicate body types, those that are related to the skeleton after maturing did not show large changes (Table 1.1.). However, changes in the chest width, chest circumference, chest depth, and weight showed a tendency to increase over the experimental period. The chest width, chest circumference, and chest depth which comprise the largest part of the upper part of the belly of a horse showed a tendency to increase as the body weight increased. The chest width significantly increased to 58 ± 2.5 kg * (*, p <0.05) at the last measurement the chest circumference increased to 181 ± 1.58 kg * (*, p <0.05), and chest depth increased to 44 ± 0.82 kg (*, p <0.05). These results indicated that the upper part of the belly gained the most weight of all parts of the body that were measured. Regarding the overall weight changes, the experimental group showed a significant increase from 265 ± 18.52 kg at the beginning of the experiment to 322 ± 27.42 kg ** (**, p <0.01) at the last measurement. The changes in the body types of the fattening horses during the experimental period were examined. According to the results, although there were no increases in the regions related to increases in the entire skeleton, changes following

increases in weight were observed. In particular, body weight showed a tendency to increase significantly compared to the control group. The increase in weight verified the efficiency of the feed in the regions related to the weight gains in the experimental group compared to the feed provided to the control group.

Table 1.1. Investigate of body type for fatting horse stages

(Unit: cm, kg)

section	M	Body length	Withers height	Back height	Croup height	Chest width	Chest girth	Chest depth	Croup length	Head length	Foreleg length	Weigth
Control	1	142±3.2	137±6.04	130±5.35	137±6.86	53±2.77	159±2.27	38±1.47	44±2.04	51±1.11	42±2.54	315±18.52
	2	142±3.2	137±6.04	130±5.35	137±7.17	54±2.77	166±3.11	39±1.22	44±2.04	51±1.11	42±2.54	334±20.7
	3	143±2.59	138±6.04	130±5.35	137±7.15	56±2.77	174±2.86	41±0.7	44±2.04	51±1.11	42±2.54	349±23.54
	4	143±2.59	138±6.04	130±5.35	137±7.15	57±2.5	181±1.58	42±0.82	44±2.04	51±1.11	42±2.54	366±27.42
Experiment	1	132±3.2	132±6.04	126±5.35	131±6.86	51±2.77	157±2.27	37±1.47	44±2.04	50±1.11	40±2.54	265±18.52
	2	132±3.2	132±6.04	126±5.35	132±7.17	53±2.77	166±3.11	40±1.22	44±2.04	50±1.11	40±2.54	283±20.7
	3	133±2.59	133±6.04	126±5.35	132±7.15	55±2.77	174±2.86	42±0.7	44±2.04	50±1.11	40±2.54	301±23.54
	4	133±2.59	133±6.04	126±5.35	132±7.15	58±2.5*	181±1.58*	44±0.82*	44±2.04	50±1.11	40±2.54	322±27.42**

Mean ± S.E. *, p <0.05, **, p <0.01.

3. Blood test and serum test

The results of blood tests (Table 1.2.), including the results of the blood cell analysis, showed no item that significantly increased or decreased hematologically in either the experimental group or the control group. The results of the serum chemical test (Table 1.3.) for Ca, IP, Mg, GLU, TCHO, AST, ALT, GGT, BUN, and CRE were examined. In the experimental group, AST increased to 319 ± 106.1 U/I (*, p <0.05) compared to the beginning, and ALT significantly increased to 18 ± 8.2 U/I (*, p <0.05). In the control group, AST significantly increased to 144.2 ± 18.2 U/I and ALT significantly increased to 9 ± 2,4 U/I (*, p <0.05). No other item significantly increased or decreased.

Table 1.2. Heamtology CBC blood sample result of body type for fatting horse stages

section	M	Item	WBC	NE	LY	MO	EO	BA	NE	LY	MO	EO	BA	RBC	Hb	HCT	MCV	MCH	MCHC	RDW
		Range	5.4~14.3	2.3~9.6	1.5~7.7	0.0~1.5	0.0~1.0	0.0~0.5	22.0~80.0	15.0~68.0	0.0~19.0	0.0~12.0	0.0~6.0	5.50~12.90	8.0~19.0	24.0~53.0	37.0~58.5	12.3~19.7	31.0~38.6	12.0~27.0
		Unit	k/uL	k/uL	k/uL	k/uL	k/uL	k/uL	%	%	%	%	%	M/uL	g/dL	%	fL	pg	g/dL	%
Control	1		9.4±1	3.6±1.1	4.9±1.2	0.6±0.2	0.2±0.1	0.04±0.02	38.8±12.3	51.9±10.8	6.6±2.2	2.4±0.6	0.4±0.1	9.4±1.3	13.5±1.2	34.4±2.5	37.3±5	14.6±1.7	39.3±1.2	27.8±1.6
	2		7.9±1.2	3.9±0.8	3.7±0.5	0.2±0.1	0.1±0	0.01±0.01	48.8±5.3	46.5±4.8	2.8±1.1	1.8±0.4	0.2±0.1	10.2±2.2	16.7±2.5	39±4.6	39.5±5.9	16.9±1.7	43±2.4	26±1.1
	3		8.4±1.6	4.4±1.3	3.5±0.6	0.3±0.1	0.1±0.1	0.02±0.01	51.6±6	42±5.6	4.6±2.4	1.6±0.4	0.2±0.1	9.9±2.1	15.4±2.5	39.8±7.7	40.7±6.4	15.8±2.1	38.9±1.6	27±0.5
	4		7.1±0.8	4±0.4	2.8±0.6	0.2±0.1	0.1±0	0.01±0.01	56.6±5.6	39.3±5.3	2.1±0.8	1.9±0.7	0.1±0.1	10±1.8	15.8±2.2	40.2±5.4	41.1±6.2	16.1±1.9	39.4±1.7	26.5±0.9
Experlment	1		9.5±1.3	3.6±0.6	5.3±0.9	0.4±0.1	0.2±0.1	0.06±0.02	38.1±3.5	55.1±3.6	3.9±1	2.2±0.7	0.6±0.2	9.4±1.2	15.3±0.7	38.6±1.6	41.8±3.6	16.5±1.3	39.5±0.5	27.3±1.9
	2		9.8±0.8	4.7±0.9	4.5±0.6	0.4±0.1	0.2±0	0.02±0.01	47.5±6.7	46.6±5.9	3.7±1.1	2.1±0.5	0.2±0.1	9.6±1.3	17.1±2.1	40.8±4.2	43.1±3.9	18±0.9	41.9±2.1	27.5±1.6
	3		10.1±1.1	5.4±0.7	4.2±0.5	0.3±0.1	0.2±0.1	0.02±0.01	53±3.3	44±6.1	3.1±1.1	2.2±1	0.1±0.1	10±1.3	17±1.2	43±1.8	43.5±4.1	17.2±1.1	39.5±1.3	26.7±1
	4		9.4±1.4	4.8±1.4	4±0.4	0.4±0.2	0.2±0.1	0.03±0.02	50.1±8.2	43±7.3	4.4±2.1	2.2±0.9	0.3±0.3	10.4±1.5	16.6±2.1	44.5±4.4	43.3±3.9	16.1±1.3	37.1±1.3	25.8±1.3

Mean ± S.E. *, p <0.05, **, p <0.01.

Table 1.3. Chemistry blood sample result of body type for fatting horse stages

section	M	Item	Ca	IP	Mg	TP	GLU	TCHO	GOT	GPT	GGT	BUN	CRE
		Range	10.4~13.4	2.3~5.4	1.8~2.7	5.7~7.9	62~114	71~142	116~287	3~21	3~22	10.4~25	
		Unit	mg/dl	mg/dl	mg/dl	g/dl	mg/dl	mg/dl	U/l	U/l	U/l	mg/dl	mg/dl
Control	1		7±0.1	2.7±0.2	1.1±0	3.6±0.2	55±29.7	34.3±6.2	138.3±21	5.3±1.1	14.3±8.6	13.8±3.4	0.7±0.2
	2		8.6±1.7	3.6±0.8	1.4±0.3	5.1±1.4	129.5±47.2	62.8±20.9	139.1±11	6.21±2.1	48.3±18.5	15.9±0.3	0.5±0.4
	3		11.2±0.8	3.2±0.5	1.8±0.2	5.5±0.8	92.5±10.3	69.8±21.2	141.5±21.2	7.3±1.3	30.3±8.9	13.9±2.6	1±0.2
	4		7.1±0.7	2.2±0.7	1±0.1	3.6±0.9	60.3±5.6	49.5±5.4	144.2±18.2	9±2.4*	18.5±4.7	7.8±1.9	0.6±0.1
Experiment	1		10±2.9	3.5±0.8	1.7±0.6	5.3±1.8	83.3±50.1	51.5±22.5	186±55.6	8.3±1.5	14.5±14.2	15±7.5	0.6±0.3
	2		10.4±1.5	3.5±1.1	1.7±0.4	5.5±1	89.5±14.9	68.8±23	202.3±40.8	12.5±4.6	43.3±25	13.2±0.7	0.9±0.2
	3		11.5±1.6	3.3±1	1.7±0.3	6.3±0.9	75.5±10.6	83±19.5	314.5±110.4	15±9.4	45.3±13.2	12±2.3	0.8±0.1
	4		7.1±0.3	2.6±0.3	0.9±0.1	4.1±1	62.8±6.8	57.3±6.4	319±106.1*	18±8.2*	32.3±11.8	8.6±2.2	0.7±0.1

Mean ± S.E. *, p <0.05, **, p <0.01.

CONCLUSION

The present study was conducted to examine the effects of the application of dedicated feed on fattening horses. The purpose of the study was to investigate the effects of feed developed for fattening horses and riding horses to enhance their productivity. The body weights, body types, feed intakes of were measured. and blood and serum analyses were conducted on eight fattening horses in the experimental group and eight fattening horses in the control group.

□ Questionnaire survey

Halla horse (Jeju Crossebred horse)

According to the results of the questionnaire survey about Halla horses, 65%, 25%, and 10% of the feed were purchased from the National Agricultural Cooperative Federation, Purina, and Woo sung Feed, respectively; 75% of the roughage was purchased from Green Farm, and the remaining 25% was produced in - house. The daily feed rations were as follows: 8 kg for each fattening horse, 2.5 kg for each growing horse (6 - 12 months), 3.5 kg for each growing horse (13 - 24 months), and 3.5 kg for each adult horse (at least 24 months). Roughage was freely provided.

□ Investigation of the body types of the fattening horses

The measurements of the fattening horses in the experimental group showed that the chest width significantly increased to 58 ± 2.5 cm * (*, $p < 0.05$) at the last measurement. The chest girth increased to 181 ± 1.58 cm * (*, $p < 0.05$), and chest depth to 44 ± 0.82 kg (*, $p < 0.05$). These results indicate that the upper part of the belly gained the greatest amount of weight. With regard to overall weight changes, the experimental group showed a significant increase from 265 ± 18.52 kg at the beginning

of the experiment to 322 ± 27.42 kg ** (**, p <0.01) at the last measurement. The changes in the body types of the fattening horses during the experimental period were examined. According to the results, although there was no increase in regions related to increases in the entire skeleton, changes following increases in weight were observed. In particular, body weight showed a tendency to increase significantly compared to the control group. Hence, the efficiency of the feed provided to the experimental group was greater than the feed provided to the control group.

□ Blood and serum tests

In the fattening horses, AST increased to 319 ± 106.1 U/I * (*, p <0.05) compared to the beginning of the experiment, and ALT significantly increased to 18 ± 8.2 U/I * (*, p <0.05). In the control group, AST significantly increased to 144.2 ± 18.2 U/I and ALT significantly increased to 9 ± 2.4 U/I * (*, p <0.05). No other item significantly increased or decreased. Similar to riding horses, AST and ALT increased in the fattening horses. The reasons are considered similar to those in riding horses. Compared to riding horses, AST and ALT values were measured as higher in the fattening horses during the experimental period. These results indicate that the riding horses performed the defined exercises after the dedicated feed was provided. The fattening horses exercised less compared to the riding horses because they were confined to their stalls. Hence, the repeated storage and utilization of energy continued in the fattening horses leading to increases in the role of the liver.

CHAPTER 2

Program Development of Horse Specific Feeding

ABSTRACT

The objectives of the present study were to develop and supply systematic feeding programs based on the nutritional requirements of individual horses according to the ages and weights of horses being raised in South Korea. Quantities of nutrients were recommended according to growth period after birth, the ratio between crude feed and concentrated feed, and the kinds of feed in order to enable efficient feeding and to minimize the economic losses caused by improper nutrition.

The body types of the growing horses were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. During the experimental period, changes were observed in the body length, withers height, back height, croup height, chest width, chest girth, chest depth, croup length, head length, antebrachium length, and the body weight. These tendencies were shown to be similar in both the experimental group and the control group of growing horses. All items investigated

showed the tendency to increas.

The body types of the brood mares were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. Slight changes appeared during the experimental period in the body length, withers height, back height, croup height, chest width, chest girth, chest depth , croup length, head length, antebrachium length, and the body weight.

The changes in the body types of the growing horses and the brood mares that resulted from changes in the feed rations were examined. According to the results, the growing horses clearly showed increases in values because they were in the phase of the highest growth. However, in the brood mares, no changes in body type resulted from changes in feed rations during the experiment period.

The results of blood tests were examined. The blood cells in whole blood were analyzed to examine the following items; WBC, LY, MO, GRAN, LY, RBC, Hb, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, PDW, and PCT. The results of the serum chemical test for TP, ALB, AST, ALT, GAT, GGT, ALP, GLU, T - BILL, NH, TG, TCHO, LDH, BUN, CREA, IP, Ca, AMYL, Lip, Mg, and UA were examined. No differences in value were found between the experimental group and the control group. In addition, all values were with in the normal range. No clinicopathologic findings were apparent in the results. Hence, no changes in enzyme and metabolism related values resulted from the changes in feed rations.

INTRODUCTION

The horse industry has demonstrated convergence with primary quintic industries such as production, raising, distribution, consumption, medical services, and leisure sports. It has received attention as a blue ocean with high future growth potential and added value. Overseas, the horse industry in advanced countries includes only horse racing, horse riding, tourism, and trekking but also the rehabilitation of disabled persons. In fact, in the USA, which has the largest horse industry in the world, there are 9.2 million horses, and 1.43 million persons are employed in horse-related occupations. Moreover, the horse industry contributes the equivalent of 126 trillion won to the economy. In Germany, which has a major horse industry, the horse-riding population is 1.7 million persons, and the number of horse-riding courses is approximately 7,600.

The 'Horse Industry Promotion Act in Korea, which was' proposed in 2008, was established on February 18, 2011 in assembly plenary session of the Assembly after undergoing adjustments for three years. When the Horse Industry Promotion Act' was established, 2011 was expected to become the first year of promotion of the horse industry. Inparticular, as the possibility of collapse of stock farmers was raised because of the spread of foot-and-mouth disease and avian influenza (AI), the need to produce domestic animals alternatives to cattle, pigs, chickens, and ducks has been strongly realized. The Horse Industry Promotion Act in Korea is not only symbolically meaningful but also is expected to become encourage the production of horse in the livestock industry similar to cattle or pigs. Recently, the livestock industry of cattle, pigs, chicken, and ducks has suffered a serious blow because of foot - and - mouth disease and the AI crisis. Because of the resulting national turmoil, horses that are free from foot - and - mouth disease and AI are expected to make a meteoric rise as the best alternative for traditional livestock. In addition, if the

horse industry is successful, South Korea have a relative advantage with regard to the issues of opening agricultural areas and environmental pollution. Compared to ruminants, horses emit less carbon gases, discharge less excretion, and cause less environmental pollution because the hardness of their manure is high. Unlike cattle, pigs, chickens, and ducks, which are raised for human consumption, horses can continuously create added value because of their diverse uses, such as horse riding for national health promotion, tourism as leisure, pet ownership, companion animals, and the rehabilitation of disabled persons.

Animals are sensitive to feed. In the wild, they eat as much food as they need. However, as livestock, they rely on humans for their food: consequently, they suffer health problems that are caused by their feed. The feed problem occurs because unified feeding is done despite the fact that horses have various dispositions or food habits. For instance, even if 10 horses have the same weight of 500 ㎏, they do not eat the same amount of feed. There are diverse reasons for these differences, such as the horses' characteristics, gender , and appetite, in addition to the climate, amount of physical exercise, and changes in feed. In addition, when the quantity is too large, horses do not eat all the feed given by humans because they eat only as much as they need. Therefore, the kinds of feed given to them are important. If excess calories and vitamins are taken, the horse may have problems. Insufficient amounts feed also can be problematic.

Horse feed is largely divided into two types: assorted feed with nutrients artificially adjusted by humans; and natural feed, which is traditional horse food. Assorted kinds of feed are made with balanced nutrients, and individual kinds of feed have distinct characteristics. Currently, diverse kind of assorted feed are produced. Natural feed includes cereals, such as oats and barley, as well as corn, hay, and herbage. Horse feed should be adjusted in proportion to the quantity of motion. On one hand, if the quantity of exercise is large but the nutrients are insufficient, the horse dose not have even strength. On the other

hand, if the quantity of exercise is small but the nutrients are plentiful, disease can occur. Because horses are herbivores, they eat grass; thus, their digestive organs are made to decompose fibers. If artificial feed (assorted feed) is improperly given, toxins may be generated and colic or various other diseases can occur. Therefore, feeding management requires careful observation, scientific mixing ratios, and exercise.

Hence, feed is very important in horse breeding. The number of horse breeding farms and the number of horses being raised on them is gradually increasing. However, horse feeding technologies have not yet been properly studied.

As mentioned earlier, the basic principle that horses nutritional requirements vary from day to day according to physiological stages and situations is not observed. Humans' intellectual means and technologies are insufficient. The required amounts of nutrition are calculated, feed mixing ratios are determined, and the quantity of feed is determined based on only on the average consumption of one horse. Consequently, horses with higher than average abilities suffer from low nutrition and become weak. Such horses show lower than average abilities. They are at high risk for excessive obesity, which leads to various problems such as breeding disorders. In the case of the pork industry or the dairy industry, which are a step ahead of the horse industry, the only management method that can increase business profits while meeting the quota is the reduction of production costs while increasing the profit margins. Thus, from the business perspective, feed should be efficiently managed to reduce costs. Hence, many studies have been conducted on feeding programs.

For instance, in the case of hog raising, feeding programs through planned feeding management methods to reduce production costs have been reported in several studies. The inheritability of the quality of meat from fattening cattle greatly affects the appearance of high-grade meat from Korean native cattle. The National Institute of Animal Science of the Agrarian Development Office developed an in-house assorted feed program that raises

cattle for short/long-term shipping times (25, 29 months after birth). After weaning at four months, they are selected from integrated breeding farms that produce fattening base cattle firsthand. This feed mixing program calculates the mixing ratios of in - house feed that can be procured according to the circumstances of integrated breeding farms at minimum cost. This feed contains the nutrient intake ability of calves in the lactation period and, during weaning. The program also provides tips for management by delivery season.

Therefore, the present study was conducted to develop and supply systematic feeding programs based on the nutrient requirements of individual horse according to the age and weight of horses raised in South Korea. The quantities of nutrients are recommended according to growth period after birth, the ratio of crude feed and concentrated feed, and the kinds of feed. The aims are to minimize economic losses caused by improper nutrient supply and to enable efficient feeding.

LITERATURE REVIEW

- Horses' Behavior -

Major study papers and conference presentations published in South Korea include "Jeju Native horse brood mares' grazing behavior" (Kang et al. 1996); "A study on Jeju Native horses' flehmen" (Kang et al. 1997); "A study on Jeju Native horse stallion studs' excretory activities" (Kang et al. 1997); "A study on Jeju Native horse brood mares' barn feeding period eating behaviors" (Kang et al. 1997); "A study on Jeju female horses'-nursing and eating" (Kang et al. 1999); "Jeju Native horse foals' resting behaviors" (Kang et al. 1999); "Jeju mountain horse foal's play behaviors" (Kang et al. 1999); "Jeju Native horse horse brood mares' eating behaviors after delivery" (Kang et al. 1999)', "Brood mares' urination and excreting behaviors in the late stage of pregnancy" (Kang et al. 2001); "Mother horses' urination and excreting behaviors after foal delivery" (Kang et al. 2001); "A study on Jeju Native horses' grazing land behaviors" (Kang et al. 2001); "A survey study on Jeju Native horses' grazing land behaviors" (Kang et al. 2003).

Jeong et al. (1994) investigated Jeju horses'eating times and resting times during grazing land and barn feeding periods. The results showed that the eating time during the April barn feeding period was 248 minutes which was 68.9% of the observed time (6 hours). The eating time during grazing on pasture was 239 minutes which was 57.0% of the observing time (7 hours) observed in May, 235 minutes which was 47.9% in June, and 299 minutes which was 71.1% in July.

In an investigation of the excretion volume and urination frequency of female Giso horses Tsujii and More (1987) found an average urination frequency

of 10.

Hafez (1969) reported that the time after mounting to ejaculation of improved stallion studs was approximately 11 sec. in the case of young stallion studs and 16 sec. in the case of adult stallion studs. The number of times of mounting per ejaculation was 5.7 times in the case of young horses and 1.4 times in the case of adult horses. The greatest number of times of mounting was 11 times in 24 hours.

Through an ethological approach, 木村 (1993) investigated the eating behavior, male and female behaviors, resting/sleeping behaviors, affiliative behaviors, exploratory behaviors, excreting behaviors, sexual behaviors, hostile behaviors, social space behaviors, and play behaviors of horses on **Yururi Island.** Based on the results, the ecological and social structures, and the relationships among individuals in horse groups under natural grazing conditions were clarified to some extent.

In her book Horse Behavior, Sae Mc Donnell (2003) provides well - organized comments on behavior type. The research on horse species is comprehensive and relatively detailed.

- Horses' nutrition -

Lee et al. (2010) reported that the excessive provision of grain feed caused excessive intake of starch. Because starch passes through the small intestine quickly, it cannot be completely digested and absorbed, so some of it flows into the large intestine where starch decomposing microorganisms (amylolytic bacteria) are activated leading to decreased pH in the large intestine, which is caused by the lactic acid produced by these microorganisms.

Medina (2002) reported that the provision of a high-starch diet to horses would increase the activity of Lactobacilli and Streptococci, which are lactic - acid producing bacteria. A high-fiber diet would lead to increased amounts of lactic acid content in the large intestine, resulting decreased pH. Meyer (1993) and de Fombelle et al. (2004) reported that horses' digestibility of starch in their small intestine varied according to the forms of cereals, and the amount of starch taken at one time affected its digestibility before it arrived at the large intestine.

Reeves (1996) reported that excessive provision of cereals to horses would cause colic, which is fatal in horses because of metabolic disorders resulting from the decrease in pH. Bailey (2002) reported that the excessive provision of cereals to horses would cause laminitis.

King (1999) reported that because of the fast fermentation of grain feed in the large intestine, gas production increases, and bowel movements decline leading to the distension of the large intestine and the occurrence of colic.

Hussein et al. (2004) reported that the measurement of the pH of horse-manure is worthwhile because the pH can be utilized as a scale to judge the metabolic condition of the large intestine.

Potter et al. (1992) reported that although when small quantities of oats are provided to horses, approximately 80% are digested before the oats arrive at the ileum (the end of the small intestine). When large quantities of oats are provided to horses, approximately 58% are digested. The starch that is not digested in the small intestine flows into the large intestine and is fermented there.

Kienzle et al. (2002) reported that concentrated feed added to straw feed

increased the rate of use of straw. The reason might be that the added nutrients enhance the concentration or activity of microorganisms.

Medina et al. (2002) reported that the negative effects of starch that flowed into the large intestine resultied from the provision of high starch feed (starch 30%), reducing the concentration of cellulose decomposing microorganisms in the appendix.

Radicke (1991) and Medina et al. (2002) reported that according to many studies, the provision of highly concentrated feed (starch) lowers the pH of the appendix and the rectum.

Radicke (1991) reported that the amount of starch that can be digested in the small intestine is 3.5 - 4 g per weight kg (Potter et al., 1992). He also reported that the pH of the appendix is lowered in a starch intake of approximately 2 - 3 g per weight kg.

Medina (2002), Goodson (1988), and Julliard et al. (2001) reported that the activity of microorganisms in the large intestine varied greatly according to the NDF/starch ratio of the feed provided to horses.

Porter (1992) and Kienzel et al. (1994) reported that when concentrated feeds are excessively provided, cereals (starch) cannot be completely digested inthe small intestine, flow into the large intestine, and are used as micro organism fermentation substrates and Goodson et al. (1998) reported that, in such cases, lactic acid is excessively produced in the large intestine.

Kohnek (1999) and Julliand et al. (2001) reported that if the excessive lactic acid produced in the large intestine exceeds the normal intestinal buffering capacity, the intestinal pH will be lowered.

MATERIAL AND METHOD

1. Test period and declared animals

In the present study, a field test was conducted with growing horses and brood mares for a total of four months from April to August 2013.

Among the experimental animals used in the present test were 30 head of growing horses that were (selected from those being raised at specialized breeding farms located in Seoguipo - si, Jeju - do, Alps horse - riding courses, and OK horse - riding courses). Included were 30 head of brood mares that were selected from those being managed in Alps horse - riding courses and OK horse - riding courses located in Pyoseon - myeon, Seoguipo - si, Jeju - do).

The growing horses and brood mares used in the test were Halla horses. The mean weight of the experimental group of growing horses was 105 ± 26.33 kg and that of the control group was 106 ± 7.27 kg. The mean weight of the experimental group of brood mares was 380 ± 79.73 kg and that of the control group was 353 ± 74.93 kg.

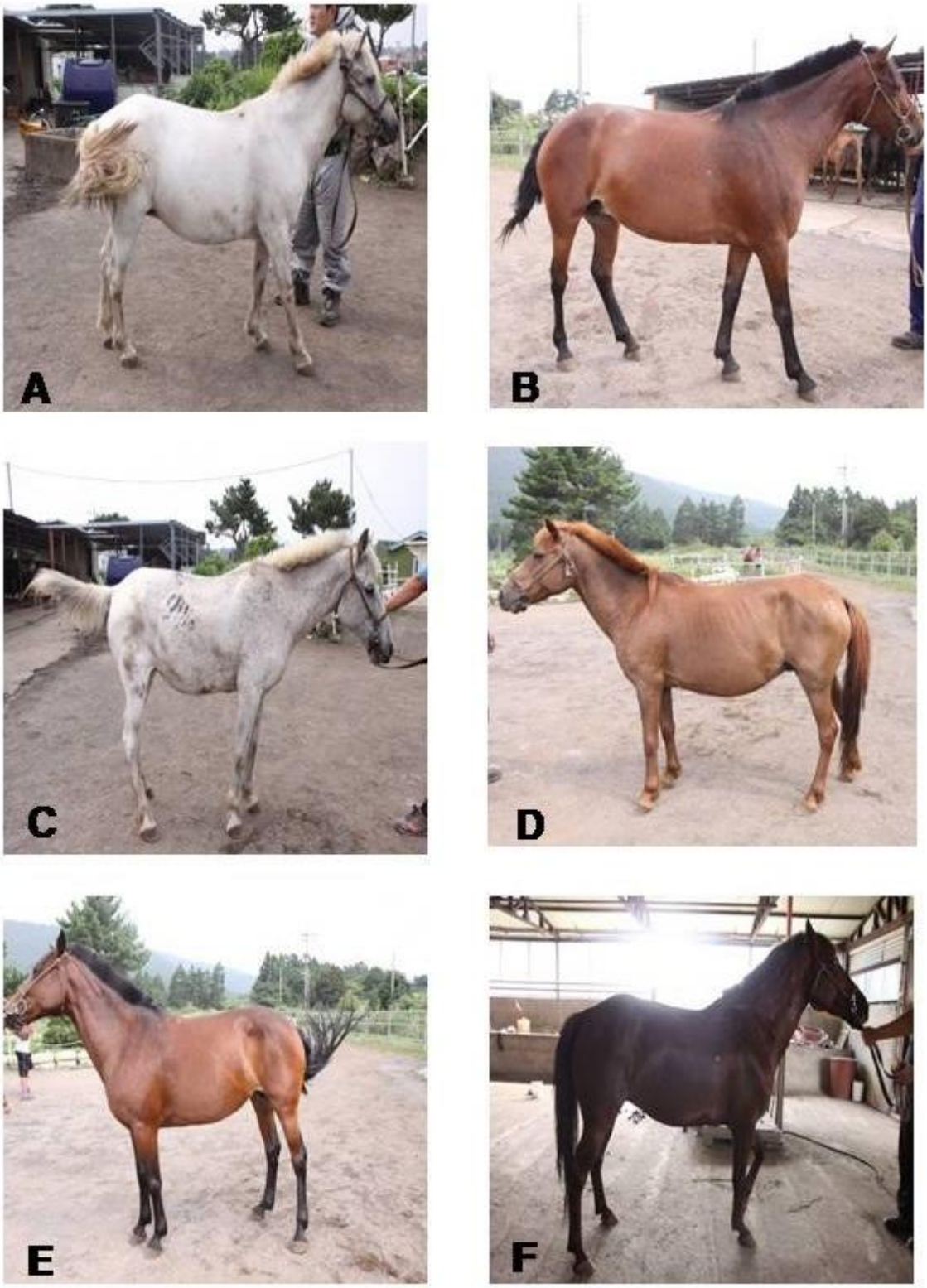

Figure 2.1. Mare horse of Laboratory animal(before control group).

A : 여왕님 B : 속전속결 C : 용의눈물 D : 왕공주 E : 똑똑이 F : 주력호

Figure 2.2. Mare horse of Laboratory animal(after control group).

A : 여왕님 B : 속전속결 C : 용의눈물 D : 왕공주 E : 똑똑이 F : 주력호

Figure 2.3. Mare horse of Laboratory animal(before experimental group).
G : 일만이 H : 명문족 I : 바람이 J : 태풍 K : 안성맞춤 L : 진한감동

Figure 2.4. Mare horse of Laboratory animal(after experimental group).

G : 일만이 H : 명문족 I : 바람이 J : 태풍 K : 안성맞춤 L : 진한감동

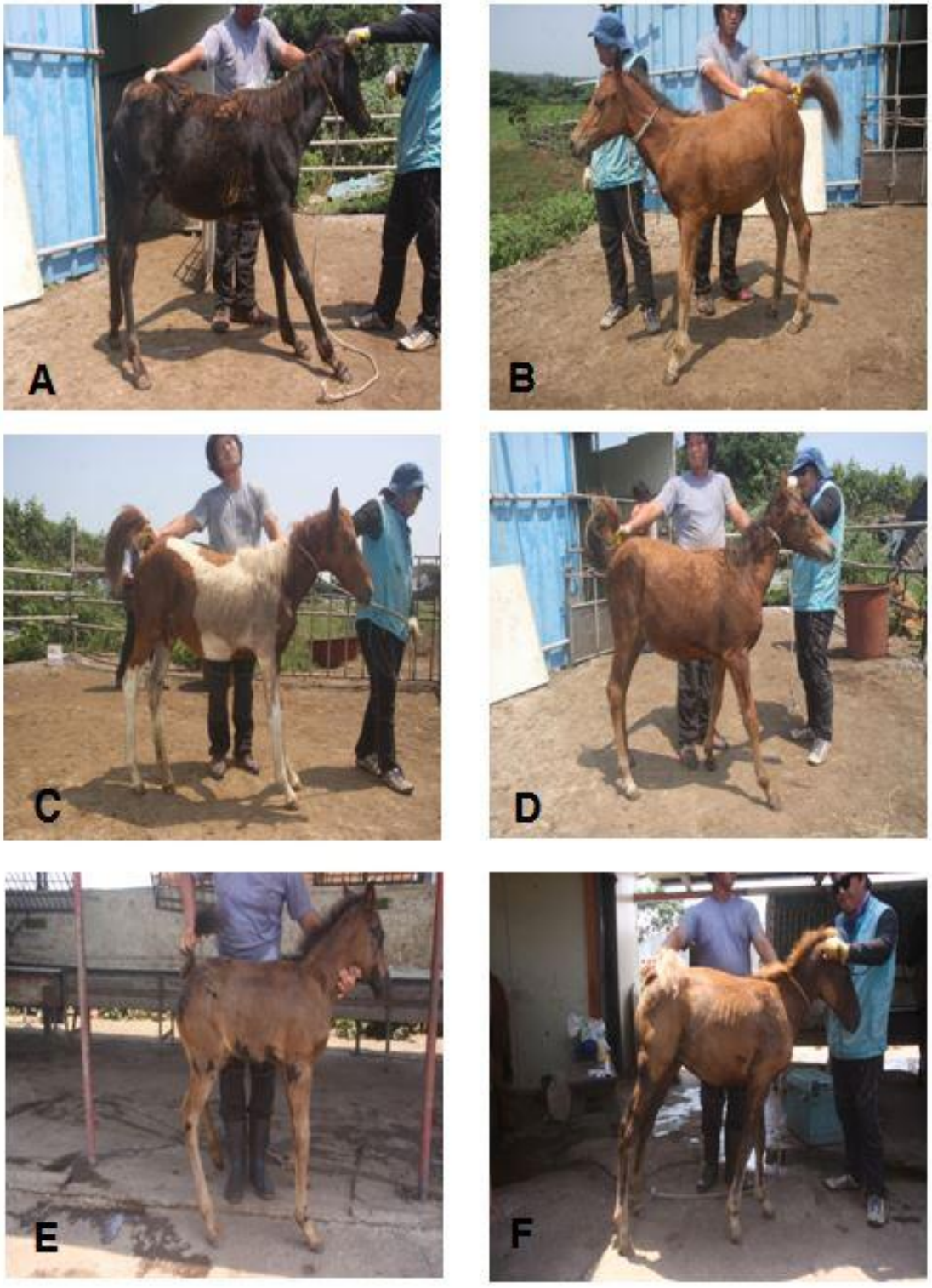

Figure 2.5. Growing horse of Laboratory animal(before control group).

Figure 2.6. Growing horse of Laboratory animal(after control group).

Figure 2.7. Growing horse of Laboratory animal(before experimental group).

Figure 2.8. Growing horse of Laboratory animal(after experimental group).

2. Experimental group assignment

The experimental group of horses was assigned by dividing the 30 head into two treatment groups, including separate control groups of growing horses and brood mares. The horses were assigned using the completely randomized block design method according to weights.

The growing horses in the control group were fed in the Alps horse - riding courses and OK horse - riding courses located in Pyoseon - myeon, Seoguipo - si, Jeju - do using the National Agricultural Cooperative Federation feed (Jeoktoma), which is identical to the feeding method used for fattening horses that are raised conventionally.

The brood mares in the control group were fed in the Alps horse - riding courses and OK horse - riding courses located in Pyoseon - myeon, Seoguipo - si, Jeju - do using the National Agricultural Cooperative Federation feed (Jeoktoma), which is identical to the feeding method used for fattening horses that are raised conventionally.

The growing horses in the treatment group 1 were provided with the National Agricultural Cooperative Federation feed (Jeoktoma) twice a day, once in the morning and once in the afternoon per individual horse.

The brood mares in the treatment group 2 were provided with the National Agricultural Cooperative Federation feed (Jeoktoma) twice a day, once in the morning and one time in the afternoon per individual horse.

3. Feeding management and provided feed

The feeding of the growing horses among the experimental animals was managed based on the conventional feeding management of Alps horse - riding courses and OK horse - riding courses located in Pyoseon - myeon, Seoguipo - si, Jeju - do. After the horses were assigned to the experimental groups, they were accommodated in a small group barn, which provided a 2 × 5 m stall for

each horse.

Assorted feed and roughage were provided to the feeding tanks, which were installed in the stalls. The feed intake and residual quantities of each horse were examined. Concentrated feed was given at 07:30 and 16:00 dailyy and hay was freely given as roughage. before the concentrated feed was given.

The litter laid on the floor of each stall was a mixture of chaff and sawdust approximately 10 cm thick. Water was freely provided by installing a water bucket in each stall.

Management logs were written periodically to prepare for the blocking of elements that were external to the experiment, such as unusual matters and diseases in individual horses. The control group was provided with 4 kg of feed per day. These horses were administered anthelminthics to control the insects in the horse stable.

The experimental group was provided with 1.5 kg, 2 kg, 2 kg, and 2.5 kg of feed per day to horses at 3 ~ 4 months, 4 ~ 5 months, 5 ~ 6 months, and 6 ~ 7months, respectively. They were administered anthelminthics to control infestation by insects in the horse stable.

The feeding of the brood mares was managed based on the conventional feeding management of the Alps horse - riding courses and OK horse - riding courses located in Pyoseon - myeon, Seoguipo - si, Jeju - do. After their assignment to the experimental groups, the horses were accommodated in a small group barn, which provided a 2 × 5 m stall for each horse.

Assorted feed and roughage were provided to the feeding tanks in each stall. The feed intake and residual quantities were examined in each stall. Concentrated feed was given at 07:30 and 16:00 every day. Hay was freely given as roughage before the concentrated feed was given.

The litter laid om the floor of each stall was a mixture of chaff and sawdust approximately 10 cm thick.

Management logs were written periodically to prepare for the blocking of elements external to the experiment such as unusual matters and diseases in individual horses. The control group was given 6 kg of feeds per day and was administered anthelminthics to control the insects in the horse stable. The experimental group was given 3.5 kg of feed per day and was administered anthelminthics to control the insects in the horse stable.

The growing horses and brood mares in the control group were fed using the National Agricultural Cooperative Federation feed, Jeoktoma (Growing horse), which is an assorted feed conventionally used in the test farms. The feeding method was identical to the feeding method used for conventionally raised fattening horses. The feed for the growing horses and the brood mares in the experimental group (Jeoktoma, National Agricultural Cooperative Federation feed) was bought from the Seoguipo Livestock Cooperatives Federation and the nutrient components were generally the same. As roughage, imported hay Italian ryegrass hay was given to the growing horse experimental group and control group. Imported blue glass hay was given to the brood mare experimental group and control group.

4. Investigation items

A. Growing horse and brood mare body type investigation test

The respective feed for the growing horse experimental group and the control group was provided throughout the experimental period. The body length, withers height, back height, croup height, chest width, chest girth, chest depth , croup length, head length, Antebrachium length, and the body weight of each horse were measured four times at intervals of one month. The intake of the provided feed was investigated in every stall. The residual amounts from the feed provided were measured daily to determine the intake. The total intake was divided by the number of horses in order to determine the average intake. All results were examined using the analysis of variance of SAS (2002). The significance of the results was tested using t - tests.

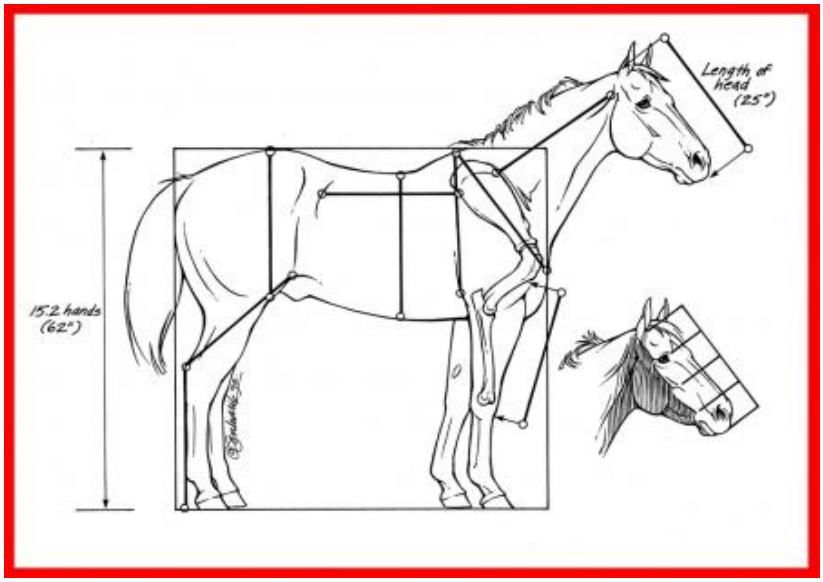

Figure 2.9. Method of investigate in measurement Jeju crossbred. horse.

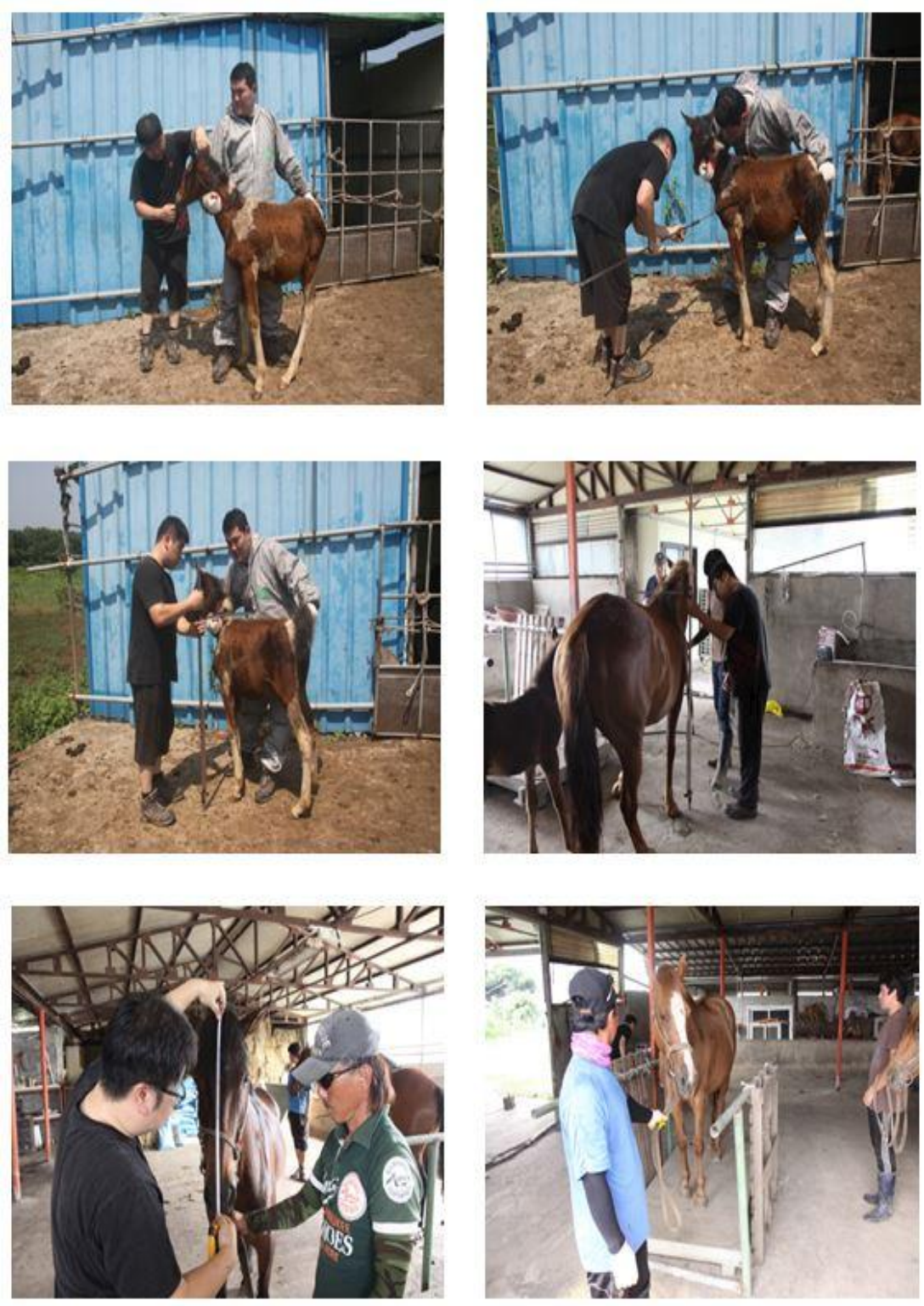

Figure 2.10. Collected experiment sample pictures of horse.

B. Brood mare bloodtest and serum test

The experimental group and the control group of brood mares were provided with the respective feed. Using 10 ml syringes, blood was collected from the cephalic vein five times at intervals of one month. To analyze the hematological findings from the collected blood, some blood was treated with EDTA, and the remaining blood was centrifuged in order to collect the serum, which was kept frozen until it was analyzed. The blood and serum were chemically analyzed as follows: red blood cells (RBC) and white blood cells (WBC) were counted using the standard clinical hematological method. Thereafter, the packed cell volume (PCV) was measured using the micro - hematocrit through centrifugation at 12,000 rpm for five minutes. In addition, Hb values were obtained by measuring the optical density at 540 nm using the cyan hemoglobin method. The mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) values were obtained using the standard clinical hematological method. In addition, the total protein, albumin, aspartate aminotrans - ferase (AST), alanine aminotransferase (ALT) alkaline phosphatase (ALP), creatinine, glucose, bilirubin, LDH, calcium, inorganic phosphorus (IP), and magnesium's serum chemical items were analyzed using an automatic serum chemical analyzer (Pronto evolution; BPC Biosed, Italy). The reagents used were from the Asan Pharmaceutical Co. (Korea). The tests sent to the Jeju Special Self - Governing Province Veterinary Service Laboratory for analysis.

RESULTS AND DISCUSSION

1. Body type investigation test

A. Growing horse

The body types of the growing horses were investigated during the experimental period. The differences in the experimental group and the control group were examined. Changes were observed during the experimental period in the body length, withers height, back height, croup height, chest width, chest girth, chest depth , croup length, head length, Antebrachium length, and the body weight (Table 2.1.). These tendencies were shown to be similar in the experimental group and control group. All areas investigated generally showed increases. The weight of the experimental horses significantly increased from 105 ± 26.33 kg at the beginning of the experiment to 144 ± 31.60 kg ** at the last experiment (**, p <0.01). The weight of the control group also significantly increased from 106 ± 7.27 kg to 137 ± 7.00 kg * at the last measurement (*, p <0.05). The body length of the experimental group of horses increased from 100 ± 15.47 cm at the beginning of the experiment to 109 ± 15.60 cm at the last measurement. The body length of the control group also increased from 104 ± 4.47 cm to 111 ± 5.07 cm at the last measurement. The withers height of the experimental group increased from 107 ± 8.13 cm at the beginning of the experiment to 117 ± 8.47 cm at the last measurement 117 ± 8.47 cm. The withers height of the control group increased from 107 ± 6.07 cm to 116 ± 6.13 cm at the last measurement. The back height of the experimental group increased from 105 ± 7.93 cm at the beginning of the experiment to 116 ± 8.13 cm at the last measurement. The back height of the control group also increased from 106 ± 5.67 cm to 114 ± 5.40 cm at the last measurement. The hip height of the experimental group increased from 109 ± 7.60 cm at the beginning of the experiment to 119 ± 9.07 cm at the last measurement. The hip height of the control group increased from 108 ± 6.67 cm to 117 ± 6.60 cm at the last

measurement. The chest width of the experimental group increased from 23 ± 3.13 cm at the beginning of the experiment to 25 ± 2.53 cm at the last measurement. The chest width of the control group increased from 23 ± 2.13 cm to 26 ± 1.73 cm at the last measurement. The chest circumference of the experimental group increased from 106 ± 4.87 cm at the beginning of the experiment to 112 ± 6.07 cm at the last measurement. The chest circumference of the control group also increased from 106 ± 6.00 cm to 112 ± 5.07 cm at the last measurement. The chest depth of the experimental group increased from 42 ± 4.80 cm at the beginning of the experiment to 44 ± 4.80 cm at the last measurement The chest depth of the control group also increased from 41 ± 2.20 cm to 43 ± 1.73 cm at the last measurement. The hip height of the experimental group increased from 32 ± 3.93 cm at the beginning of the experiment to 34 ± 4.07 cm at the last measurement. The hip height of the control group also increased from 31 ± 1.80 cm to 33 ± 1.53 cm at the last measurement. The head length of the experimental group increased from 41 ± 5.27 cm at the beginning of the experiment to 42 ± 5.07 cm at the last measurement. The head length of the control group increased from 41 ± 1.27 cm to 42 ± 1.20 cm at the last measurement. The shank circumference of the experimental group increased from 15 ± 2.07 cm at the beginning of the experiment to 16 ± 1.67 cm at the last measurement. The shank circumference of the control group increased from 14 ± 1.33 cm to 15 ± 1.27 cm at the last measurement. A tendency toward increased shank circumference was observed, which increased over time and was similar in the experimental group and in the control group.

B. Brood mare

The body types of the brood mares were investigated during the experimental period. The differences that were observed in each experimental group and control group were examined. No changes were identified during the experimental period in the body length, withers height, back height, croup height, chest width, chest girth, chest depth, croup length, head length, antebrachium length, and the body weight (Table 2.2). The weight of the experimental group of horses increased from 380 ± 79.73 kg at the beginning of the experiment to 384 ± 81.67 kg at the last measurement. The

weight of the control group also increased from 353 ± 74.93 kg to 359 ± 67.93 kg at the last measurement. The body length of the experimental group horses was 146 ± 11.47 cm at the beginning of the experiment and 146 ± 11.47 cm at the last measurement. The body length of the control group was 145 ± 14.93 cm at the beginning of the experiment and 145 ± 14.93 cm at the last measurement. The withers height of the experimental group was shown to be 139 ± 11.27 cm at the beginning of the experiment and 139 ± 11.20 cm at the last measurement. The withers height of the control group was 139 ± 9.60 cm at the beginning of the experiment and 139 ± 9.60 cm at the last measurement. The back height of the experimental group was 130 ± 9.53 cm at the beginning of the experiment and 130 ± 9.53 cm at the last measurement. The back height of the control group was 132 ± 7.40 cm at the beginning of the experiment and 132 ± 7.40 cm at the last measurement. The croup height of the experimental group was 137 ± 10.53 cm at the beginning of the experiment and 137 ± 10.47 cm at the last measurement. The croup height of the control group was 138 ± 9.73 cm at the beginning of the experiment and 138 ± 9.80 cm at the last measurement. The chest width of the experimental group was 41 ± 7.27 cm at the beginning of the experiment and 41 ± 7.33 cm at the last measurement. The chest width of the control group was 41 ± 17.60 cm at the beginning of the experiment and 42 ± 17.33 cm at the last measurement. The chest circumference of the experimental group increased from 175 ± 17.20 cm at the beginning of the experiment to 176 ± 17.53 cm at the last measurement. The chest circumference of the control group increased from 171 ± 18.00 cm to 172 ± 36.13 cm at the last measurement. The chest depth of the experimental group increased from 63 ± 9.33 cm at the beginning of the experiment to 64 ± 9.53 cm at the last measurement. The chest depth of the control group was 60 ± 16.07 cm at the beginning of the experiment and 60 ± 15.47 cm at the last measurement. The hip length of the experimental group was 47 ± 5.33 cm at the beginning of the experiment and 47 ± 5.33 cm at the last measurement. The hip length of the control group was 48 ± 8.60 cm at the beginning of the experiment and 48 ± 8.60 cm at the last measurement. The head length of the experimental group was 52 ± 2.73 cm at the beginning of the experiment and 52 ± 2.73 cm at the last measurement. The head length of the control group was 51

± 3.53 cm at the beginning of the experiment and 51 ± 3.53 cm at the last measurement. The antebrachium length of the experimental group was 20 ± 2.67 cm at the beginning of the experiment and 20 ± 2.67 cm at the last measurement. The antebrachium length of the control group was 20 ± 1.53 cm at the beginning of the experiment and 20 ± 1.53 cm at the last measurement. With regard to overall tendencies, no changes in body type were observed in the experimental group or the control group during the experimental period.

According to the above results, no changes occurred in the body types of the brood mares that were fed with different types of feed.

Table 2.1. Investigate of body type for growing horse

(Unit: cm, kg)

section	M	Body length	Withers height	Back height	Croup height	Chest width	Chest girth	Chest depth	Croup length	Head length	Foreleg length	Weigth
Control	1	104±4.47	107±6.07	106±5.67	108±6.67	23±2.13	106±6.00	41±2.20	31±1.80	41±1.27	14±1.33	106±7.27
	2	106±4.47	109±6.33	108±5.80	110±6.87	24±1.73	108±6.67	42±2.47	31±1.60	41±1.27	14±1.33	114±8.07
	3	108±5.93	112±6.13	111±5.53	113±6.60	25±2.73	110±5.87	43±2.33	32±2.13	41±1.27	15±1.20	125±6.73
	4	111±5.07	116±6.13	114±5.40	117±6.60	26±1.73	112±5.07	43±1.73	33±1.53	42±1.20	15±1.27	137±7.00
Experiment	1	100±15.47	107±8.13	105±7.93	109±7.60	23±3.13	106±4.87	42±4.80	32±3.93	41±5.27	15±2.07	105±26.33
	2	103±15.53	109±8.20	108±8.50	110±9.47	24±3.47	101±82.40	42±5.07	33±4.60	42±5.73	15±1.33	113±28.27
	3	105±15.87	112±8.20	111±8.00	113±9.33	24±2.67	109±5.47	43±5.13	34±4.60	42±5.00	15±1.33	126±29.40
	4	109±15.60	117±8.47	116±8.13	119±9.07	25±2.53	112±6.07	44±4.80	34±4.07	42±5.07	16±1.67	144±31.60

Mean ± S.E. *, $p < 0.05$, **, $p < 0.01$.

Table 2.2. Investigate of body type for brood mare horse

(Unit: cm, kg)

section	M	Body length	Withers height	Back height	Croup height	Chest width	Chest girth	Chest depth	Croup length	Head length	Antebrachium length	Weigth
Control	1	145±14.93	139±9.60	132±7.40	138±9.73	41±17.60	171±18.00	60±16.07	48±8.60	51±3.53	20±1.53	353±74.93
	2	145±14.93	139±9.60	132±7.40	138±9.73	41±17.60	171±17.93	60±15.13	48±8.60	51±3.53	20±1.53	355±70.87
	3	145±14.93	139±9.60	132±7.40	138±9.80	42±17.27	172±36.87	60±15.40	48±8.60	51±3.53	20±1.53	359±65.47
	4	145±14.93	139±9.60	132±7.40	138±9.80	42±17.33	172±36.13	60±15.47	48±8.60	51±3.53	20±1.53	359±67.93
Experiment	1	146±11.47	139±11.27	130±9.53	137±10.53	41±7.27	175±17.20	63±9.33	47±5.33	52±2.73	20±2.67	357±62.71
	2	146±11.47	139±11.33	130±9.53	137±10.53	41±7.33	175±17.33	63±9.40	47±5.33	52±2.73	20±2.67	358±84.73
	3	146±11.47	139±11.27	130±9.53	138±10.47	41±7.33	175±16.47	64±9.60	47±5.33	52±2.73	20±2.67	360±11.07
	4	146±11.47	139±11.20	130±9.53	138±10.47	41±7.33	176±17.53	64±9.53	47±5.33	52±2.73	20±2.67	361±83.07

Mean ± S.E. *, p <0.05, **, p <0.01.

2. Blood test and serum test

A. Mare horse

The results of blood tests were examined (Table 2.3.). The blood cells of whole were analyzed to examine the following items: WBC, LY, MO, GRAN, LY, RBC, Hb, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, PDW, and PCT. The values of individual blood cell were examined, and the ratios of individual blood cells were verified three different ways. The results of the experiments of the experimental group and the control group showed no change during the experimental period. No large hematological differences were found between the experimental group and control group. Therefore, based on the results of the comparison between the experimental group and the control group, no hematologically predictable clinical symptom or disease occurred as a result of the changes in feed rations such as inflammation, platelet abnormality, and dehydration.

The results of the serum chemical test (Table 2.4.) for TP, ALB, AST, ALT, GGT, ALP, GLU, T - BILL, NH, TG, TCHO, LDH, BUN, CREAK, IP, Ca, AMYL, Lip, Mg, and UA were examined. There were no differences in value in the experimental results between the experimental group and the control group. In addition, the values of all results were within the normal range, and no clinicopathologic findings were observed. No negative effects were evident in the changes in enzyme and metabolism related values that resulted from the changes in the feed.

Table 2.3. Hematology CBC blood sample result of body type for mare horse

section	M	Item	WBC	LY	MO	GRAN	LY	MO	GRAN	RBC	Hb	HCT	MCV	MCH	MCHC	RDW	PLT	MPV	PDW	PCT
		Range	5.4~14.3	1.5~7.7	0.0~1.5	0.0~1.5	0.0~1.0	0.0~0.5	22.0~80.0	5.50~12.90	8.0~19.0	24.0~53.0	37.0~58.5	12.3~19.7	31.0~38.6	12.0~27.0				
		Unit	k/uL	k/uL	k/uL	k/uL	%	%	%	M/uL	g/dL	%	fL	pg	g/dL	%	k/uL	fL		%
Control	1		7.3±4.0	3.2±2.1	0.4±0.1	3.7±1.8	44.2±23.4	5.0±1.3	50.8±22.4	7.3±1.8	10.7±2.2	35.2±7.6	48.2±4.7	14.6±1.7	30.4±1.3	17.5±1.4	130.8±94.2	5.5±1.1	16.4±1.0	0.071±0.047
	2		7.7±3.3	3.1±2.7	0.9±0.3	4.1±1.6	39.6±24.3	5.7±1.9	54.6±23.6	7.5±2.5	10.9±2.9	35.2±8.6	47.5±5.1	14.6±1.4	30.9±1.3	17.8±1.1	119.8±78.8	5.7±1.1	16.1±0.7	0.068±0.046
	3		7.5±3.6	2.6±2.0	0.4±0.2	4.6±2.3	33.7±19.2	5.6±1.3	60.7±19.0	8.8±5.3	13.7±6.6	42.3±20.5	48.1±5.0	15.5±1.4	32.2±1.2	17.8±1.1	119.9±62.9	5.6±0.8	16.4±0.7	0.067±0.037
	4		7.3±4.2	3.5±3.1	0.5±0.3	3.3±2.4	47.4±34.2	7.0±3.1	45.6±34.5	10.1±3.2	14.9±7.0	49.2±22.8	48.8±5.6	14.7±1.8	30.3±1.2	17.7±1.0	122.1±43.1	5.5±0.6	16.3±0.7	0.067±0.022
	5		7.7±4.8	3.7±2.3	0.5±0.4	3.5±4.4	48.5±24.1	6.5±2.2	45.0±23.0	8.4±6.6	11.2±3.7	40.3±33.4	48.2±4.3	13.6±3.7	28.2±8.0	17.9±0.7	106.9±78.9	5.5±0.6	16.7±0.9	0.057±0.042
Experiment	1		6.7±2.5	3.0±1.3	0.4±0.2	3.3±2.2	45.7±14.5	5.7±2.0	48.5±15.0	6.8±3.0	10.3±5.0	34.0±16.0	50.2±3.5	15.1±1.0	30.1±1.4	17.3±1.2	121.6±98.4	5.4±0.7	16.5±1.0	0.064±0.048
	2		7.0±2.9	2.0±1.2	0.4±0.3	4.6±2.5	29.3±11.7	6.2±1.9	64.5±11.9	7.5±2.0	11.3±3.6	36.5±11.8	49.0±3.5	15.1±1.0	30.9±1.6	17.8±0.8	121.2±100.8	5.5±0.9	16.3±0.5	0.067±0.050
	3		6.6±3.4	1.9±1.2	0.4±0.3	4.4±2.7	27.7±10.6	5.7±0.9	66.6±10.0	9.0±2.6	14.2±3.9	44.6±11.9	49.7±3.4	15.8±1.0	31.8±1.5	17.8±1.1	128.9±98.1	5.4±0.6	16.3±0.4	0.069±0.046
	4		7.0±2.6	2.8±1.7	0.5±0.2	3.7±2.3	40.0±21.7	7.4±1.4	52.6±21.5	8.8±3.2	13.5±4.6	44.1±14.3	50.2±3.2	15.3±1.0	30.6±0.9	17.4±1.1	125.5±140.5	5.6±0.8	16.7±0.7	0.069±0.058
	5		7.2±3.1	3.6±2.4	0.5±0.3	3.1±1.7	49.4±18.0	6.6±1.3	44.0±17.2	7.8±1.8	11.4±3.7	38.9±11.4	49.8±3.2	14.5±2.1	29.2±5.0	17.3±1.3	133.1±298.9	5.4±1.9	16.8±2.2	0.076±0.239

Mean ± S.E. *, p <0.05, **, p <0.01.

Table 2.4. Chemistry blood sample result of body type for mare horse

section	M	Item	TP	ALB	GOT	GPT	GGT	ALP	GLU	T-Bill	NH_3	TG	TCHO	LDH	BUN	CREA	IP	Ca	AMYL	Lip	Mg	UA
		Unit	g/dl	g/dl	U/l	U/l	U/l	U/l	L	mg/dl	H	mg/dl	mg/dl	H	mg/dl	mg/dl	mg/dl	mg/dl	L	U/l	mg/dl	mg/dl
Control	1		7.0± 0.8	3.1± 0.3	363.0± 405.0	10.9± 26.1	37.3± 39.7	652.2± 242.8	66.2 ±21.2	1.3 ±0.8	175.1± 188.9	4.1± 8.9	76.9± 41.1	642.7± 221.7	21.7± 7.0	0.9± 0.5	4.5± 2.1	12.8± 1.1	4.4± 2.4	31.9± 29.1	2.1± 0.5	0.7± 0.3
	2		6.7± 0.6	3.1± 0.3	340.1± 323.9	7.7± 7.3	31.4± 17.6	449.9± 220.1	70.3 ±85.7	1.5 ±0.8	306.0± 228.0	3.1± 4.9	74.0± 23.0	602.4± 260.6	19.4± 3.7	0.9± 0.4	3.1± 0.9	12.4± 1.0	6.9± 2.9	617.± 33.3	2.1± 0.7	0.7± 0.3
	3		7.2± 0.8	3.2± 0.2	303.1± 212.9	8.8± 10.2	33.0± 34.0	543.7± 191.7	44.3 ±39.3	1.4 ±0.7	225.7± 197.3	4.1± 4.9	89.5± 33.5	627.3± 260.3	19.6± 5.3	0.9± 0.4	3.7± 2.3	13.0± 0.7	5.9± 3.1	48.6± 49.4	2.2± 0.3	0.7± 0.4
	4		7.2± 1.0	3.2± 0.2	273.4± 95.4	6.7 ±6.3	32.4± 80.6	552.6± 200.6	49.7 ±54.3	1.2 ±0.9	191.6± 133.6	5.5± 3.5	78.9± 18.1	639.9± 275.9	20.3± 5.5	1.0± 0.3	2.5± 1.1	13.0± 0.9	7.3± 5.7	56.2± 41.8	2.2± 0.6	0.7± 0.4
	5		6.9± 0.9	3.2± 0.3	233.9± 107.1	4.9 ±14.1	26.5± 8.5	564.9± 198.9	13.6 ±14.4	1.3 ±1.0	223.2± 203.8	4.0± 5.0	76.2± 20.8	574.9± 278.1	17.3± 4.8	1.0± 0.4	5.3± 1.5	12.5± 1.5	6.0± 4.0	49.8± 48.2	2.1± 0.5	0.6± 0.4
Experiment	1		7.0± 0.5	3.2± 0.3	361.1± 138.1	10.4± 7.6	43.9 ±32.1	512.1± 157.9	59.5 ±40.5	1.5 ±0.9	288.4± 144.4	16.7± 133.3	94.6± 33.6	713.3± 186.7	21.7± 5.0	1.0± 0.6	3.7± 1.1	12.9± 1.3	6.1± 5.9	49.4± 27.6	2.2± 1.0	0.8± 0.3
	2		6.7± 0.7	3.2± 0.2	328.7± 93.3	7.4± 2.6	33.4 ±18.6	521.1± 155.1	65.7 ±23.3	1.5 ±0.8	308.9± 133.9	3.0± 5.0	96.1± 33.1	673.2± 168.8	21.0± 3.3	0.9± 0.4	2.9± 1.0	12.9± 1.1	6.4± 6.6	45.3± 20.7	2.2± 0.5	0.6± 0.4
	3		6.9± 0.6	3.1± 0.3	352.0± 416.0	8.9± 9.1	35.8 ±31.2	523.9± 371.1	66.1 ±21.1	1.3 ±1.2	274.9± 348.1	4.2± 4.8	85.1± 37.9	660.3± 239.3	21.4± 6.7	0.9± 0.4	3.6± 3.0	12.9± 1.3	4.9± 3.1	41.9± 33.3	2.1± 0.6	0.7± 0.3
	4		7.0± 0.8	3.2± 0.2	275.6± 240.4	7.0± 4.0	28.0 ±6.0	573.8± 171.2	48.7 ±22.7	1.6 ±0.9	380.0± 243.0	3.9± 3.1	91.3± 24.7	616.3± 337.3	19.3± 6.7	1.0± 0.4	2.6± 1.3	13.2± 0.9	7.1± 8.9	53.7± 44.3	2.2± 1.3	0.6± 0.4
	5		7.0± 0.8	3.1± 0.2	257.6± 114.4	3.9± 14.1	28.0 ±5.0	606.3± 288.7	7.0 ±6.0	1.6 ±0.9	349.4± 273.6	7.3± 56.7	91.7± 46.3	613.1± 245.1	18.1± 3.8	1.1± 0.4	5.6± 4.6	13.0± 0.7	6.5± 3.5	50.3± 26.7	2.1± 0.5	0.6± 0.4

Mean ± S.E. *, p <0.05, **, p <0.01.

Conclusion

The objectives of the present study were to develop and supply systematic feeding programs based on the nutritional requirements of individual horses according to the ages and weights of horses being raised in South Korea. Quantities of nutrients were recommended according to growth period after birth, the ratio between crude feed and concentrated feed, and the kinds of feed in order to enable efficient feeding and to minimize the economic losses caused by improper nutrition.

□ Growing horse and brood mare body type investigation

A. Growing horse

The body types of the growing horses were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. During the experimental period, changes were observed in the body length, withers height, back height, croup height, chest width, chest girth, chest depth, croup length, head length, Antebrachium length, and the body weight. These tendencies were shown to be similar in both the experimental group and the control group of growing horses. All items investigated showed the tendency to increas.

B. Brood mare

The body types of the brood mares were investigated during the experimental period. The differences that were observed in the experimental groups and the control groups were examined. Slight changes appeared during the experimental period in the body length, withers height, back height, croup height, chest width, chest girth,

chest depth, croup length, head length, Antebrachium length, and the body weight.

The changes in the body types of the growing horses and the brood mares that resulted from changes in the feed rations were examined. According to the results, the growing horses clearly showed increases in values because they were in the phase of the highest growth. However, in the brood mares, no changes in body type resulted from changes in feed rations during the experiment period.

□ Blood and serum tests

The results of blood tests were examined. The blood cells in whole blood were analyzed to examine the following items; WBC, LY, MO, GRAN, LY, RBC, Hb, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, PDW, and PCT. The results of the serum chemical test for TP, ALB, AST, ALT, GGT, ALP, GLU, T - BILL, NH, TG, TCHO, LDH, BUN, CREA, IP, Ca, AMYL, Lip, Mg, and UA were examined. No differences in value were found between the experimental group and the control group. In addition, all values were with in the normal range. No clinicopathologic findings were apparent in the results. Hence, no changes in enzyme and metabolism related values resulted from the changes in feed rations.

요 약

본 연구는 사육 용도에 따른 비육마에 맞게 개발된 전용사료를 급여함에 따라 용도별 말에 적용하였을 때 체중, 체형, 사료섭취량, 혈액 및 혈형청 분석 조사하여 사육용도별 말의 생산성 향상에 미치는 영향을 알아보기 위해 본 연구를 수행하였다.

□ 설문 조사

한라마(제주산마)

한라마에서 설문조사 결과 사료 구입처는 농협이 65%, 퓨리나 25%, 우성사료가 10% 비율을 보였으며 조사료 생산은 그린팜에서 75% 구입하며 자가 생산은 25%인 것으로 나타났다. 비육마인 경우 하루 급여량 8kg, 육성마(6-12개월령)인 경우 하루 급여량 2.5kg, 육성마(13-24개월령)인 경우 하루 급여량 3.5kg, 성마(24개월 이상)인 경우 하루 급여량 3.5kg 급여하고 있었으며 조사료는 자유급식을 하고 있는 것으로 나타났다.

□ 비육마 체형조사

비육마에서 전체적인 체형조사 중 흉폭은 마지막 측정 시 58±2.5kg * (*,p<0.05), 흉위는 181±1.58kg *(*, p<0.05), 흉심 44±0.82kg(*, p<0.05)로 유의성 있게 증가하였다. 체형 중에서 체중이 늘어가는 부위가 체위 측정부위 중 상복부라는 것을 알려주고 있으며 전반적인 체중 변화를 살펴보면 실험군은 실험 초 체중이 265±18.52kg에서 마지막 실험 시 322±27.42kg ** (**,p<0.01)으로 유의성 있게 증가하였다.

비육마의 실험기간동안의 체형변화를 살펴본 결과 전체적인 골격의 증가와 관련된 부위의 증가는 없었으나 체중의 증가에 따른 변화는 관찰되었다. 특히나 체중은 대조군에 비하여 유의성 있게 증가하는 경향성을 보여주었으며 체중의 증가를 통하여 대조군 급여사료에 비하여 체중의 증가와 관련된 부분에서 효율성을 검증 할 수 있었다.

□ 혈액 및 혈청검사

비육마의 실험군에서 AST는 처음에 비하여 319±106.1 U/I(*, $p<0.05$)로 증가하였고, ALT는 18±8.2 U/I(*, $p<0.05$)로 유의성 있게 증가하였고, 대조군에서는 AST는 144.2±18.2 U/I, ALT는 9±2.4 U/I(*, $p<0.05$)로 유의성이 있게 증가하였다. 다른 항목들은 유의성 있게 증가 혹은 감소하는 항목들은 없었다. 비육마의 실험군에서 AST 및 ALT 측정치가 전용사료 급여에 따른 시간이 지날수록 높게 측정되는 것으로 보아 축사 내에서 활동성을 최소화하는 여건으로 운동량이 적어 비육마에서 에너지의 저장 및 활용을 반복하는 과정이 지속되어 간의 역할이 확대된 것으로 사료된다.

국내에 사육중인 말에서 나이 및 몸무게에 따른 개체별 영양소 요구량의 계산과 생후성장 시기별 영양소 권장량, 조·농 비율 및 구분에 따른 체계적인 사료 급여 프로그램 개발 및 보급을 통해 잘못된 영양소 공급으로 인한 경제적 손실을 최소화하고 효율적인 사료 급여를 가능케 하기 위해 본 연구를 수행하였다.

□ 육성마 및 종빈마 체형조사

가. 육성마

육성마에서 실험기간 동안 체형을 조사하여 본 결과 실험군 및 대조군에서의 각각의 차이를 알아보았다. 체장, 체고, 배고, 고고, 고장, 두장, 관위, 흉폭, 흉위, 흉심과 같은 부위는 실험기간동안 변화가 나타났다. 이러한 경향성은 육성마 공시동물로 선택되어진 동물들은 실험군 및 대조군에서 유사한 경향성으로 전반적인 체형조사의 각 항목이 증가하는 경향성을 나타냈다.

나. 종빈마

종빈마에서 실험기간 동안 체형을 조사하여 실험군 및 대조군에서의 각각의 차이를 알아보았다. 체장, 체고, 배고, 고고, 고장, 두장, 관위, 흉폭, 흉위, 흉심과 같은 부위는 실험기간동안 변화가 미약하게 나타났다.

이렇듯 육성마 및 종빈마에서 사료 급여량의 변화에 따른 체형의 변화를 살펴본 결과 육

성마에서는 가장 많은 체형적 성장이 이루어지는 시기에 따른 증가는 분명히 나타났다. 하지만 시기에 따른 사료 급여량이 변화되는 것에 따라 차이가 나타나지 않음을 알 수 있었고, 종빈마에서도 또한 조사항목의 변화가 크게 나타나지 않은 것으로 보아 급여량에 따른 종빈마에서 체형의 변화는 없는 것으로 보여진다.

□ 혈액 및 혈청검사

혈액 검사 결과를 살펴보면 전혈을 이용하여 혈구 분석을 해본결과 WBC, LY, MO, GRAN, LY, RBC, Hb, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, PDW, PCT 항목을 조사하여 봤으며, 혈청화학적검사는 TP, ALB, GOT, 헷, GGT, ALP, GLU, T-BILL, NH_3, TG, TCHO, LDH, BUN, CREA, IP, Ca, AMYL, Lip, Mg, UA
를 살펴보았다. 실험군 및 대조군 실험 결과가 수치상 실험 진행에 따른 변화는 나타나지 않았다. 또한 결과치는 정상범위 내에서만 나타나 일부분 변화에 대한 임상병리학 상의 소견은 나타나지 않았다. 사료 급여량의 차이로 인한 혈액학상의 효소 및 대사 관련 수치들의 변화로 인하여문제가 발생하지 않음을 알 수 있었다.

따라서 사육시기별 급여량은 일반적인 농가에서는 비육마인 경우 하루 급여량 8kg, 육성마(6-12개월령)인 경우 하루 급여량 2.5kg, 육성마(13-24개월령)인 경우 하루 급여량 3.5kg, 성마(24개월 이상)인 경우 하루 급여량 3.5kg 급여하고 있었다.

본 실험을 통하여 성마기준으로 3.5kg, 3~4개월령 1.5kg, 4~5개월령 2kg, 5~6개월령 2kg, 6~7개월령 2.5kg을 급여하는 것이 가장 효율적인 급여임을 알 수 있었다. 국내에 사육중인 말에서 나이 및 몸무게에 따른 개체별 영양소 요구량의 계산과 생후성장 시기별 영양소 권장량, 조·농 비율 및 구분에 따른 체계적인 사료 급여 프로그램 개발 및 보급을 통해 잘못된 영양소 공급으로 인한 경제적 손실을 최소화 하고 효율적인 사료 급여를 가능하게하기 위하여 추가적인 연구가 필요할 것으로 사료된다.

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감사의 글

2015년 12월의 마지막 일요일에 박사학위청구 심사과정을 마치고 논문의 마지막 감사의 글을 작성하고 있으니 13년간 제주도에서 학부과정, 석사과정, 박사과정동안 일어났던 모든 일들이 주마등처럼 지나가는 것 같습니다.

동물을 좋아하고 사랑하게 되어 이곳으로 오게 되었으며 많은 분들에게 도움을 받으면서 제주도에서 삶을 시작한 것 같습니다. 학부과정을 다니면서 많이 부족한 저에게 많은 조언을 해주시고 학문적인 지식을 많이 전해주신 지도교수 강 민수 교수님이 있으시기에 제가 여기까지 올 수 있었으며, 이 과정까지 진행할 수 있었습니다. 평생의 학문스승님이시며 잊지 못할 은사님이시며 평생 잊지 못할 은혜에 깊이 머리숙여 감사드립니다.

바쁜 일정 가운데도 저의 부족한 논문에 알찬 내용을 조언해주시고 세심하게 심사를 해주신 황 규계 교수님, 고 한종 교수님, 권 태준 박사님, 전 경익 박사님의 세심한 배려와 조언이 있었기에 박사학위논문을 완성할 수 있어 대단히 감사하게 생각하고 있습니다. 또한 대학원 박사과정을 통해 학문의 견문을 다양하게 공부할 수 있도록 도와주시고 지켜봐주신 양 영훈 교수님, 정 동기 교수님, 류 연철 교수님, 이 왕식 교수님, 오 성종 교수님께 감사하다는 말을 전하고 싶습니다. 더불어 학위를 마무리할 수 있게 불평불만 없이 열심히 도와준 변 재현 조교선생님과 강 예솔 조교선생님께도 감사드립니다.

제가 제주도에 와서 학부과정을 끝내고 석사과정을 들어갔을 때 방황하고 있던 저에게 앞으로 나갈 수 있는 길을 알려주며 학위과정을 진행하는 동안 많은 조언과 저에게 무슨 일이 생기면 항상 같이 걱정해주고 고민해주며 동고동락했던 발생공학실험실 권태준 팀장님께 정말 감사하고 고맙다는 말을 전하고 싶으며, 실험실에 들어왔을 때 많은 일을 도와줬던 박 준형, 오 명운 고맙다는 말을 전하며 학위논문을 잘 준비하라고 이야기해준 강 옥득 박사님 그리고 이번에 학위논문을 같이 준비하며 고생한 박 석재 원우, 김 경호 원우 평생 동안 잊지 못

할 기억이 될 것 같습니다.

논문을 열심히 준비하는 동안에 많은 격려와 도움을 주신 대학원 박사과정의 김 덕문, 문 효숙, 김 성룡, 이 은정, 김 영진, 최 한호 원우님께 감사하다는 말을 전하고 싶습니다. 그리고 대학원 생활하는 동안 도움을 준 고 경보, 강 동근, 김 정현, 임 도훈, 양 익동, 고 미정, 박 행철, 이 영화, 김 성미, 김 미나, 김 제석, 김 대수 등 대학원생들에게 고맙고 감사드립니다.

낯선 땅인 제주도에 처음 왔을 때 많은 이야기와 도움을 주신 김 동석 선배님, 홍 충협 선배님, 오 인세 선배님께 감사하다고 전하고 싶으며 학교생활을 함께 했으며 제주도에서 많은 고민을 나누는 태현이, 이번에 힘든 일 있었던 용길이 힘내구, 멀리서 열심히 살고 있는 일이에게도 고맙다는 말을 전하고 싶습니다. 그리고 학교후배 윤호, 준호, 나래, 경환, 시내, 순희, 경은, 상미, 혜진 고맙다고 전하고 싶습니다. 그 외 도움을 주신 많은분들 감사합니다.

그리고 타지에서 생활을 항상 신경써주시는 큰아버지, 큰어머니, 작은아버지, 작은어머니, 사촌형 재성이형과 형수, 재현이형과 형수, 사촌동생 재은, 재향, 재용이등 사촌식구와 외가집 식구 및 사촌과 큰이모, 둘째 이모 모두 항상 걱정해 주셔서 감사합니다.

끝으로 여기까지 올 수 있도록 응원해준 동생 재경이와 매제에게도 고맙다고 전하며, 전폭적인 지지를 해주시며 항상 아프지 말고 건강하게 지내고 하는 일 열심히 할 수 있게 많은 도움을 주신 아버지, 어머니의 희생과 도움이 없었으면 이 자리에 제가 없었을 지도 모르며, 어려운 일을 해결할 수 있도록 아낌없는 조언과 격려를 해주신 부모님께 다시 한번 감사하다는 말을 전하고 싶습니다.

2015년 12월

배 재 호