# THESIS OF DOCTORAL (Ph.D.) DISSERTATION

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# INFLUENCE OF BREED, FORCE-FEEDING TECHNOLOGY AND STUNNING METHOD ON LIVER, CARCASS AND MEAT QUALITY OF FATTENED GEESE

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# 1. INTRODUCTION

In fattened goose-liver production, Hungary stands first in the World. Our country takes 65-70 % of total French import. Further exporters are Romania, Israel and Bulgaria. In turn, the year-by-year increasing French goose-liver produced by large-scale fattening is a deserving fact.

This increased French production is accompanied with decreasing demand that has an extreme drawback effect on Hungarian goose-liver production. The increment of French fattened goose-liver production is obviously imputable to the poor quality of the Hungarian products. Since concomitantly with continuou diminution of export costs the costs of production are increasing, Hungary may be ousted from the international market. French government supports financially researches that aim the development of large-scale fattening methods.

In this thesis we had a complex method in view by which the most important quality damaging factors of fattened goose-liver could be suppressed. On behalf of the realization of the work, we have examined the followings:

- Effect of applied goose hybrids on liver quality.
- Effect of force-feeding method on liver size and quality.
- Effect of force-feeding methods on exploitablicity of regions (breast, thigh) that improve economical indexes of export.
- Applicability of starter cultures in preparation of force-feeding fodder.

- Possible decreasing of liver weight loss during removal of blood vessels and tissular hemorrhage by decreasing stress during stunning.

Our experiments, that were financially supported by the National Committee of Technical Development, were performed in the industrial unit of Merian Finom Szárnyas Különlegességek Részvénytársaság in Orosháza.

# 2. MATERIALS AND METHODS

## 2.1. Procedure of experiment

### *2.1.1. Fattening methods*

Three goose hybrids were chosen: Kolos, Babati and Gourmaud. In favor of comparable results hybrids were grown up under same circumstances from the age of baby geese. Birds went under serotherapy against Derzsy's disease. This immunotherapy was repeated on the 12$^{th}$ postnatal day of birds. Combined vitamin treatment was executed once a week. For substitution of minerals 'Zeovit' was placed on tray near to feeders. Gravels were mixed to foodstuff assisting digestion and supplying function of gizzard.

Birds were fed with fodder produced according to internal values prescribed in Hungarian Codex of Animal Feeding (Magyar Takarmánykódex).

For feeding geese Hungarian traditional feeding-method was applied:

- Starting feed: 3 kg/goose,
- Breeding feed: 6 kg/goose,
- Force-feeding: *Ad libitum* until the day of transport.

Geese were reared for 62 days. Breeding diary was taken to note down events happened during rearing.

In Table 1 the most important natural indexes of breeding hybrids are shown.

**Table 1**

The most important natural indexes of the three goose-hybrids

| Examined parameters | Hybrids | | |
|---|---|---|---|
| | Kolos | Babati | Gourmaud |
| Fodder consumption (kg) | | | |
| Starting | 3 | 3 | 3 |
| Breeding | 6 | 6 | 6 |
| Force-feeding | 4.5 | 2.8 | 3.2 |
| Total fodder consumption (kg) | 13.5 | 11.8 | 12.2 |
| Mean of live weight on the 62nd postnatal day (kg/goose) | 4.83 | 4.18 | 4.56 |
| Specific fodder consumption (kg/goose/fodder kg) | 2.79 | 2.82 | 2.67 |
| Geese transported (No. of animals) | 947 | 953 | 969 |
| Death rate (%) | 5.3 | 4.7 | 3.1 |

Traditional and large-scale (with Israeli origin) force-feeding technology were applied. Evaluating force-feeding methods examined it can be concluded that Kolos and Gourmaud hybrids took intense force-feeding better than Babati hybrids did.

Applying large-scale force-feeding method fodder was composed according to the recommendation of a French company called TECHNA. This component contained corn-grits, minerals and vitamins.

For traditional force-feeding fatteners enriched fodder with 0.5-0.7% salt (weight in dry matter) and 1-2% fat.

As a new variant of large-scale force-feeding mixed and cooled fodder was inoculated with starter culture of *Lactobacillus plantarum* (in 0,5% concentration) 12 hours before feeding. Since temperature of environment exceeded the 15°C, lactic acid fermentation was ensured.

This alternative force-feeding method was performed on 90 geese (30 Kolos, 30 Babati, 30 Gourmaud) bred on the same farm. In the case of alternative feeding 16 day-long, while in large-scale method 20-day-long force-feeding period was applied.

Before transporting birds to the abattoir, all the three hybrids were marked for easier identification.

After transportation but before slaughtering, the live weight of birds was measured. Taking to pieces of birds happened after cutting, plucking and pre-cooling (for 12 hours). Hybrids and force-feeding methods were compared according to the following parameters:

- Body weight gain during force-feeding;
- Liver weight;
- Quality of livers;
- Thigh weights;
- Weights of breasts.

Qualification of goose-livers was executed according to the sectoral norms. Defining thigh and breast meats was to meet demands of export.

## 2.2. Examination of stunning methods

The stunning methods examined were as follows:

- 'CAS' (Controlled Atmosphere Stunning), a gaseous stunning /STORK/,
- Stunning with high frequency /LINK GMBH),
- Stunning with high frequency /STORK/ combined with different frequencies and voltages.

Traditional stunning system (50Hz, 50V, 75mA) of Merian Rt was used as control.

The two-step system of CAS is shown in Table 2.

**Table 2**

Description of Controlled Atmosphere Stunning system

| | **First phase** | **Final phase** |
|---|---|---|
| Time of staying in gaseous environment | Min. 1 second | Min. 2 seconds |
| Gaseous atmosphere | ~30% $O_2$ (±2%)<br>~40% $CO_2$ (±4%)<br>~30% $N_2$ (the remainder) | ~5-15% $O_2$ (±2%)<br>~80%C $O_2$ (±4%)<br>$N_2$ (the remainder) |
| Temperature | 20°C (±5°C) | 20°C (±5°C) |
| Relative humidity | 60-65% | |

The basic parameters of electrical stunning are shown in Table 3.

**Table 3**

Main Parameters of Electrical Stunning Methods

| **Stunning system** | **Frequency (Hz)** | **Volatge (V)** | **Amperage (mA)** |
|---|---|---|---|
| Control | 50 | 50 | 75 |
| Linco | 200 | 100 | 75 |
| STORK 1. | 50 | 50 | 75 |
| STORK 2. | 200 | 90 | 75-85 |
| STORK 3. | 200 | 110 | 89-90 |
| STORK 4. | 350 | 50 | 60-70 |
| STORK 5. | 350 | 70 | 75-80 |
| STORK 6. | 350 | 90 | 80-85 |
| STORK 7. | 350 | 110 | 85-90 |

## 2.3. Qualification of goose-livers

During estimation of goose-liver quality the following parameters were noted:

- Visual examination of the external part of livers;
- Color of external part of livers;
- hemorrhage of external tissues of livers;
- Liver-weight;
- Determination of loss of liver-weight during removal of blood vessels.

## 2.4. Examination of meat quality

Examination of meat quality was characterized as follows:

- Tissular hemorrhage of thigh and breasts;
- Amount of residual blood in thighs and breasts;
- Color of meats.

One and two-way analysis of variance, calculation of correlation and linear regression were used for evaluating results.

# 3. RESULTS AND DISCUSSION

## 3.1. Studies on goose-hybrids and force-feeding methods

### *3.1.1. Development of liver-weight and liver quality in the function of goose-hybrids and of force-feeding methods.*

Liver-weight means in the function of goose-hybrids and of force-feeding methods were found as is shown in Fig. 1. The less significant difference depended on both hybrids and force-feeding method was 65.4 g liver-weight mean deviation.

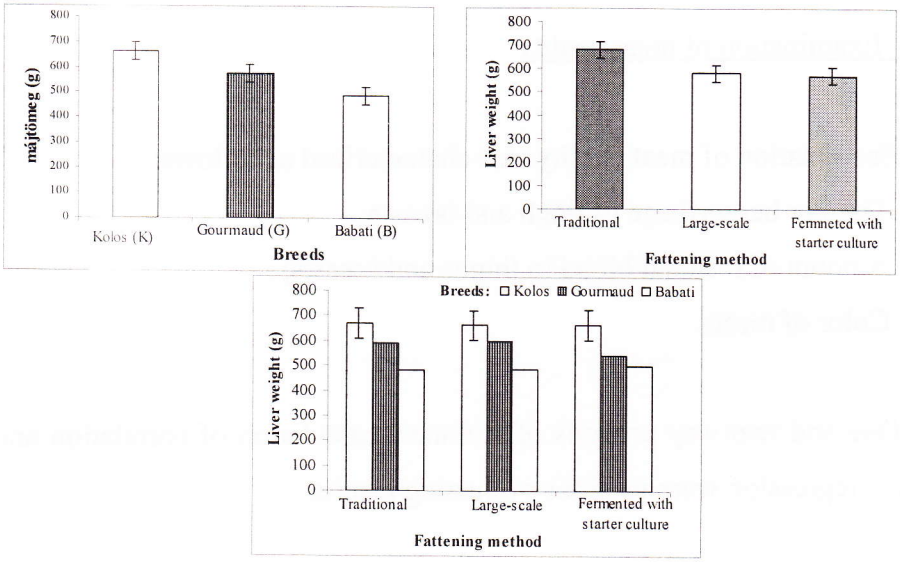


**Fig. 1.** Liver weight means of different geese hybrids and of various force-feeding methods

As can be seen in Fig. 1., during fattening liver weight gain was influenced only by goose-hybrids significantly while force-feeding

method had only effect on the efficacy of feeding and of economical characteristics of fattening.

Qualification of goose-livers in the function of fattening methods and of breeds is illustrated in Fig. 2.

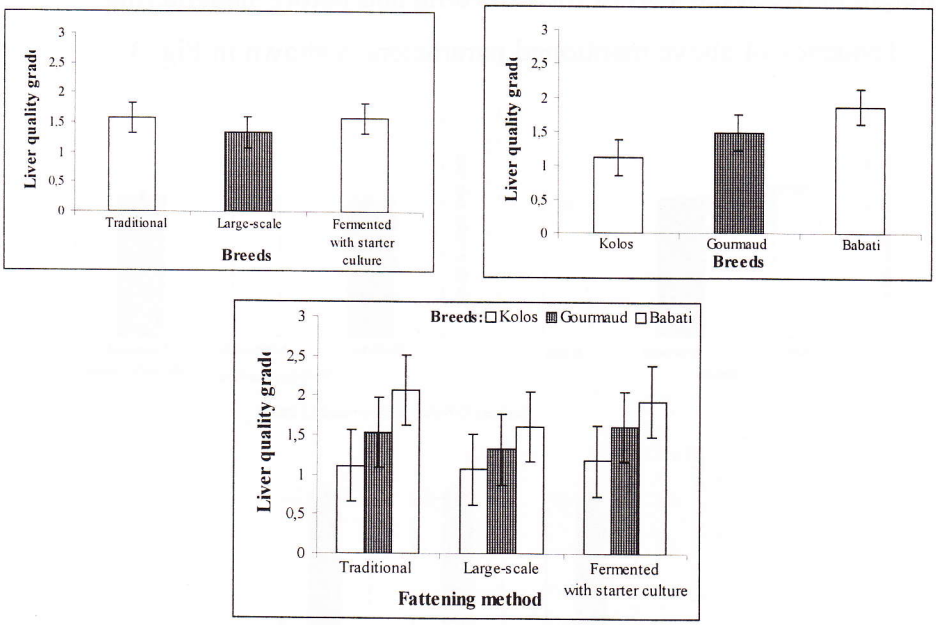


**Fig.2.** The effect of different goose-hybrids and of force-feeding methods on liver quality grade

Liver quality grade was primarily affected by goose-hybrids although a well-defined tendency in proving liver quality can be seen in the case of large-scale fattening. Fodder fermented with *Lactobacillus plantarum* had a significantly adverse effect on liver quality of Kolos hybrids. This phenomenon may be due to an increased concentration of lactic acid in the feed.

### *3.1.2. Relationship in increase in body weight, fattened liver weight and liver quality*

The terms 'increase in body weight' means the difference in live weight between the start of force-feeding and before slaughtering.

Tendency of above mentioned parameters is shown in Fig. 3.

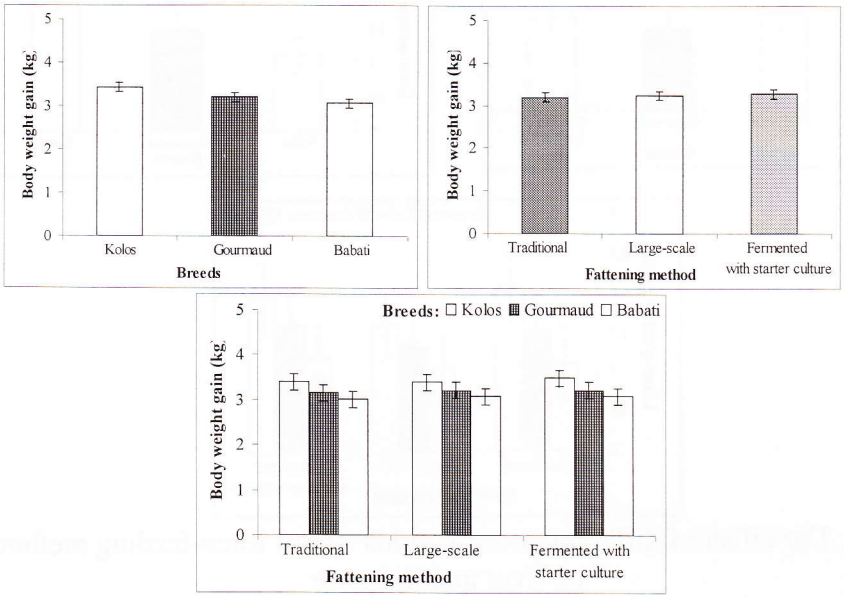


**Fig. 3.** Body weight gain of different goose-hybrids during force-feeding methods

Body weight gain during force-feeding depended on the hybrid used but was unaffected by force-feeding method. The body weight gains of the three goose-hybrids are slightly yet significantly different.

Evaluating 270 data a close correlation (r=0.98) between final liver weight and fattening weight was observed. (fig.4.)

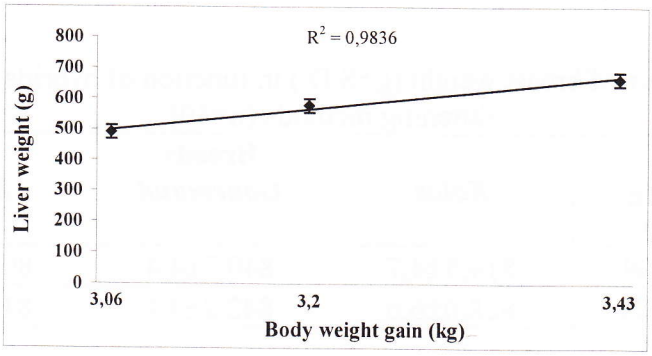


**Fig. 4.** Correlation between liver weight and body weight gain during force-feeding (LSD 95% around straight is ±22 g)

Similarly to the above demonstrated figure, a close relationship was detected between liver quality grade and body weight for the larger the liver weight the higher the liver quality grade will be.

### *3.1.3. Weights of goose breasts and thighs*

As previous examinations proved, the modified large-scale fattening method (fodder fermentation by *L. plantarum*) did not result in significantly bigger body weight gain thus we passed over its evaluation.

Tendency of breast weight in function of force-feeding methods and of hybrids is summarized in Table 4.

Since standard deviation of breast weights within certain breeds was not more than 4 g, the relatively small mean deviations between hybrids were significant in all cases. Mean of breast weights of Gourmaud

hybrids was above the two other examined breeds, justifying the purpose of its breeding.

**Table 4**

Tendency of breast weight (g±S.D.) in function of hybrids and of fattening methods (n=30)

| Fattening method | Breeds | | |
|---|---|---|---|
| | ***Kolos*** | ***Gourmaud*** | ***Babati*** |
| Traditional | 814,5±4,7 | 840,2±4,4 | 803,1±6,5 |
| Large-scale | 828,0±6,6 | 842,2±4,1 | 812,0±3,2 |

Differences in weights of thighs were significant both between fattening methods and between hybrids, although these differences were not so large.

**Table 5.**

Tendency of mean of thigh weights (g±S.D.) in function of goose-hybrids and of fattening methods (n=30)

| Fattening methods | Breeds | | |
|---|---|---|---|
| | Kolos | Gourmaud | Babati |
| Traditional | 755,3±15,3 | 761,8±6,9 | 739,2±4,8 |
| Large-scale | 760,4±13,2 | 771,4±8,4 | 744,9±5,3 |

Evaluating our results presented here, it can be concluded that in Hungary the most economical production of fattened geese can be realized with Gourmaud goose-hybrid. Fattened liver production of this breed is optimal and meat production of Gourmaud hybrid is the best among the hybrids examined. This can be said also in connection with basic costs.

## 3.2. Studies on Controlled Atmospheres Stunning and Conventional Electrical Stunning

Since examinations on goose-hybrids have revealed that the most economical and optimal hybrid was the Gourmaud, comparative studies on decreasing fattened liver hemorrhage and improving of liver quality were performed on the above mentioned breed.

### *3.2.1. External tissular color and hemorrhage of fattened liver and loss of liver weight during removal of blood vessels on the 2nd day after cutting*

Mean scores of external tissular colors both after traditional and CAS stunning method were 2.2 (according to qualification specified by the company). Thus the effect of stunning methods on liver color did not differ.

In the case of traditional electrical stunning system value of external tissular hemorrhage was 1.1 and CAS stunning resulted in almost the same value: 1.2.

Loss of liver weight during removal of blood vessels as the most important parameter is shown in Fig. 6.

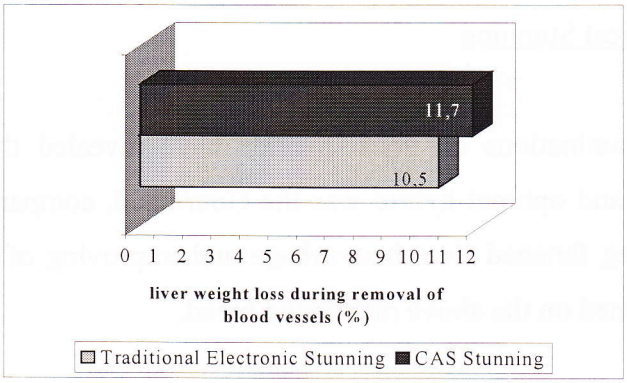


**Fig. 6.** Loss of liver weight during removal of blood vessels on the 2nd day after cutting

*3.2.2. Meat quality (breast and thigh) in function of stunning methods*

Although with respect to muscular hemorrhages, residual blood and color, the CAS stunning method seemed to be significantly more advantageous than traditional electronic stunning the, costs of such an alternative stunning system are so high that changing traditional stunning method to CAS would not be economical.

## 3.3. Studies on effects of different stunning parameters on loss of fattened liver weight

Since the CAS system did not decrease the most important parameter –loss of liver weight during removal blood vessels- to an appropriate degree, alternative stunning methods that could have a positive effect on liver quality were examined.

Two high-frequency stunning systems were applied for the study. To control the results traditional main frequency stunning system was used. Stunning parameters and results on loss of liver weight are shown in Table 6.

**Table 6**

Effects of stunning methods on loss of liver weight during removal of blood vessels

| Loss of liver weight (%) | | | |
|---|---|---|---|
| Linco | 11,456* | Control | 10,97 |
| C.A.S. | 11,41$^{0}$ | Control | 10,44 |
| Stork 50V 50Hz | 14,71* | Control | 9,95 |
| 90 V 200 Hz | 11,77$^{0}$ | Control | 11,29 |
| 110V 200Hz | 12,16$^{0}$ | Control | 11,29 |
| 50 V 350 Hz | 10,54$^{0}$ | Control | 10,63 |
| 70 V 350 Hz | 8,67** | Control | 10,63 |
| 90V 350Hz | 7,68** | Control | 9,95 |
| 110 V 350 Hz | 11,75* | Control | 9,95 |

LSD 95%
* = treated is significantly worse than control,
0 = no significant difference,
** = treated is significantly better than control.

As it can be seen 70V and 90V and 350Hz are the optimal stunning parameters.

# 4. NEW SCIENTIFIC RESULTS

- Concluding our results presented here, it can be said that among the three goose-breeds examined (Kolos, Gourmaud and Babati) Kolos hybrid produced the biggest liver weight and the best quality of fattened liver. Comparing Kolos and Gourmaud hybrids differences were significant but did not strikingly differ.

- Independently from goose-hybrids, the traditional fattening method resulted in better liver quality and bigger liver weight than the large-scale force-feeding method.

- Independently from force-feeding methods and hybrids, close relation between body weight gain during fattening, liver weight and liver quality was noticed.

- Among goose-hybrids (Kolos, Gourmaud and Babati) cut after force-feeding Gourmaud geese gave the biggest breast and thigh weights. Although the mean deviation was significant, absolute mean values did not show a decided difference.

- By CAS stunning method, that has never been used for stunning water-fowls, loss of liver weight during removal of blood vessels did not decrease in higher degree than did by traditional electrical stunning system. Although to a slight extent, but CAS does have a

significantly advantageous effect on quality of goose breast and thigh (muscular hemorrhage, color and residual blood).

- Comparing changes of parameters of two different electrical stunning systems in respect of stress-decreasing effect, operating STORK poultry stunning system with 70 or 90V, 350Hz and 80-85mA seemed to be the most prosperous to loss of liver weight during removal of blood vessels.

# 5. SUMMARY

Liver weight production of the most popular goose breeds bred in Hungary were examined. Effect of force-feeding methods on liver and meat quality was also studied. Controlled atmosphere stunning and various electrical stunning methods were compared in the view of the most beneficial production and liver quality production during slaughtering. Complementary studies on relationship in quality liver and fine meat production of geese were also examined.

Effects of goose-hybrids (Kolos, Gourmaud and Babati) and force-feeding methods (traditional, large-scale feeding and fattening with fermented fodder) on following parameters were examined:

- Liver weight,
- Liver quality grade,
- Body weight gain during fattening,
- Thigh and breast weights.

Evaluating our results we can conclude that:

- The five studied parameters of the three examined goose-hybrids were significantly different.
- With respect to liver weight and liver quality Kolos hybrid gave the most favorable results.
- Body weight gain during fattening was the highest of Kolos hybrid.
- Capacity indexes of thigh and breast (fine meats) concomitantly with the specific costs were the highest in the case of Gourmaud goose-hybrids.

- Babati hybrid produced the poorest quality with respect to all the five parameters examined.

A close relation between both body weight gain during fattening and liver weight or liver quality grade was noticed independently from breeds.

In view of meat weights, differences in mean deviations were small but significant in the case of the large-scale fattening method.

Although Kolos hybrids had slightly better liver quality than Gourmaud had, meat quality and breeding parameters (egg and baby-goose/layer; better hatchability, more advantageous fodder-utilization and growth rate) of the latter breed were more favorable. Thus Gourmaud goose-hybrid was selected for further examinations.

Studies on stunning methods for decreasing liver hemorrhage and stress

Four stunning systems were applied:

- Traditional stunning system (50V, 50Hz) as control;
- STORK A.G. Controlled Atmosphere Stunning system that was used in this study for the very first time in the world,
- High frequency stunning system (100V, 200Hz) produced by Linco GMBH;
- Stunning system by STORK A.G. with variable frequency and voltage.

Appraising the results the followings can be concluded:

- CAS method deceased neither the loss of liver weight during removal of blood vessels nor tissular hemorrhage. Not even improvement in liver color was detected.
- CAS produced better but not significant thigh and breast quality.
- Loss of liver weight was significantly less applying STORK A.G. stunning system with voltage of 70 and 90V and frequency of 350Hz, applied amperage was 80-85mA. With respect to liver quality and economical indexes, this stunning system with the mentioned parameters is recommended for stunning fattened water-fowls.

## 6. PUBLICATIONS IN THE THEME OF THESIS

1.1. Publications in foreign language

SZIGETI J., TURCSÁN ZS., BIRKÁS E., BONYHÁDI I. – VARGA A. (1999): Relationship of increase in body weight, fattened liver weight and liver quality in geese of different breeds, determined on the basis of force feeding methods. *Acta Alimentaria*, 1999. 28(3), 251-260

TURCSÁN J., VARGA L., TURCSÁN ZS., SZIGETI J. – FARKAS L (2000): Occurrence of anaerobic bacterial spores, clostridial and *Clostridium perfringens* spores in raw goose livers from a poultry-processing plant in Hungary. *Journal of Food Protection* (in press)

1.2. Publications in Hungarian language

TURCSÁN ZS. (1992): Examination of effects of certain parameters on fattened goose-liver quality and quantity. (Egyes tényezők hatásainak vizsgálata a libamáj minőségére és mennyiségére). Thesis, Mosonmagyaróvár

TURCSÁN ZS. (1994): Analysis of project conception of Poultry Processing Plant of Pannonliver's pedigree stock. (A Pannonliver Baromfifeldolgozó Rt. tenyészanyagellátás tervkoncepciójának elemzése). Thesis, Mosonmagyaróvár