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ASSESSMENT OF THE FIXATION PRINCIPLE OF GOAT MILKING INSTALLATIONS BY THE HYPOTHESIS TEST FOR MEAN

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Abstract: *The effect of the fixation principle was investigated in its application in the arrangements of goats on the platform of the side-by-side linear milking installations. The following fixation principles were applied: "Random fixation principle" and "Arranged fixation principle". The working hypothesis is that the fixation principle has a significant influence on the quality of the operational process of the milking installation. The following qualitative assessment indicators are formulated to evaluate the influence of the fixation principle: "Working conditions of the operators-milkmen", "Welfare of goats" and "Productivity level of goats". The effect of the arranged fixation principle on the selected rating indicators was assessed by the random fixation principle used as a comparative base. The equation hypothesis for the average value of a normally distributed random variable is applied. At the significance level α = 0.05 was checked the validity of the null hypothesis "The principle of arranged fixation does not change the quality of the operational process of the milking installation". The results of the study show that the null hypothesis is rejected for the three assessment indicators and justify the claim that the principle of arranged fixation has a significant positive impact and helps to improve the quality of the operational process of the milking installation. The influence over the indicator "Working conditions of the operators" had the most prominent impact - guarantee probability P = 3.71E-8. Similar was the result for the indicator "Welfare of goats": P = 2.38E-7. There was the lowest impact on the indicator "Productivity Level": P = 3.90E-4.*

***Key words*: goats, goat milking, milking installation, fixation, fixation principles, statistical hypothesis**.

1. INTRODUCTION

The fixing system is an essential element of the technological construction of the side-by-side linear milking installations for goats.
A priori studies on the fixation systems of the linear milking installations [4] justify the formulation of two principles for fixing the animals when stacked on the milking platform: *"Random fixation principle"*[1] and *"Arranged fixation principle"*[2]. A working hypothesis that "The principle of fixation has a significant impact on the quality of operational process of the milking installation" has been raised.
The influence of the fixation principle on the quality of the operational process is assessed using evaluation indicators. In terms of the possibility of their objective assessment, the evaluation indicators are classified as quantitative and qualitative [2]. Quantitative indicators are objectively measurable and have a specific numeric expression. Unlike quantitative, qualitative indicators are objectively immeasurable, as there are no objective numerical expression [3].

The aim of the present research is to assess the influence of the fixation principle on the qualitative evaluation indicators.

2. MATERIAL AND METHODS

The qualitative evaluation indicators included in this study were determined on the basis of the a priori studies on the problem, followed by the evaluation using expert evaluation method [1].
The study was conducted in a milking parlour for goats where is fitted a 24-place, single-row milking installation, *side-by-side* type. Milking installation is equipped with 12 milking clusters and is operated by two operators-milkmen. Milking technology provides for feeding animals with concentrated fodder in the milking process.
In the course of the study, the milking installation was successively equipped with two fixing systems, developed,

[1] The fixation systems to which the principle of random fixation is applied are characterized by the possibility that each animal, after entering the milking platform, occupies "at random" any vacancy at the feeder for concentrated fodder.

[2] The fixation systems to which the principle of arranged fixation is applied are characterized by the limitation of the animal, after entering the milking platform, being able to occupy a single and precisely defined vacant place immediately adjacent to the previous fixed animal.

respectively, on the principle of random and arranged fixation. Because of technological limitations, the study was conducted in two consecutive lactations (in two consecutive calendar years).

To evaluate the influence of the fixation principle on the quality of the operational process of the milking installation, the following qualitative indicators were filtered (Table 1):

Table -1: Qualitative indicators for evaluation of the influence of fixation principle

№	Name of indicator
1.	Working conditions of the operators-milkmen
2.	Welfare of goats
3.	Productivity level of goats

1. Working conditions of the operators-milkmen

This is a comprehensive indicator that measures the physical and mental energy consumption of servicing personnel in performing the actual milking and ancillary technological operations.

2. Welfare of goats

This indicator takes into account the welfare and the level of stress in goats affected by the milking group conflicts and the compulsory interventions of the servicing personnel during the milking process.

3. Productivity level of goats

The "Productivity level of goats" indicator is included in the quality indicator group, therefore the experimental study was conducted during different lactation periods (in two consecutive calendar years). This determines differences in the conditions of the different experiment stages, which excludes the objective quantitative comparability of the obtained results for the production level.

In the assessment of the impact of the fixation principle on the selected qualitative indicators, the methods of the expert evaluation and the equation hypothesis for the average value of a normally distributed random variable were used.

For the conditions of the particular study, it is accepted that the fixing system established on the principle of *random* fixation should be considered as *a basic* variant and the fixation system established on the principle of *the arranged* fixation as *an experimental* variant.

According to the expert assessment method, 11 experts were asked to answer the following inquiry question: "Compared to the principle of *random* fixation, what is the influence of the principle of *arranged* fixation on the following qualitative indicators?"

In the realization of the investigation was used the questionnaire presented in Table 2. To formalize the information processing, a preliminary ranking of the possible answers was carried out, according to the legend to the table.

Table -2: Questionnaire for evaluation of the influence of fixation principle on the quality of operational process

№	Evaluative indicators	Answers *)				
		- 2	-1	0	1	2
1.	Working conditions of the operators-milkmen					
2.	Welfare of goats					
3.	Productivity level of goats					

**) Legend of answers:*

"Negative"	"Rather negative"	"No change"	"Rather positive"	"Positive"
-2	-1	0	1	2

The assessment of the influence of the fixation principle on the qualitative indicators is done through the equation hypothesis for the average value of a normally distributed random variable. STATGRAPHICS program [5] was used to process the results.

At "Random *Fixation Principle*" as a basis of comparison was raised the null hypothesis of "Principle of *Arranged Fixation* does not change the quality of the operational process of the milking installation", i.e.

Ho: E[Y] = μ,

where *E[Y]* is the mean of the general population;

- *μ* is the set value with which we compare the mean value (in this case *μ=0*, according to the legend of the answers in Table 2).

The validity of the null hypothesis is checked at a level of significance (risk of error) α = 0.05.

To verify the hypothesis, the criterion was used:

$$t = \frac{|\bar{Y} - \mu|}{S}\sqrt{n},$$

where $\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} y_i$ and $S = \sqrt{\frac{1}{n-1}\sum (y_i - \bar{Y})^2}$ are respectively the sample mean and the standard deviation;

- *n* - the sample volume.

In case of a true null hypothesis, this criterion has a Student's ***t***-distribution with degrees of freedom *k = n - 1*.

The critical area of the hypothesis (the area of *Ho* rejection) is determined by the alternative hypothesis

H_1*: E[Y] ≠ μ.*

This critical area is two-sided and has boundaries

$$|t| \geq t_{кр} = t_{\frac{\alpha}{2};k}$$

If the calculated value of the criterion $t < t_{\frac{\alpha}{2};k}$ or the guarantee probability $P(t,k) > \alpha \Rightarrow Ho: E[Y] = \mu = 0$, i.e. the zero hypothesis does not contradict the experimental data and is considered to be true. This means that, compared to the principle of *random fixation*, the principle of *arranged*

fixation does not affect the quality of the operational process of the milking installation.

If $t \geq t_{\frac{\alpha}{2};k}$ or the guarantee probability $P(t,k) < \alpha \Rightarrow Ho: E[Y] \neq \mu \neq 0,$

i.e. the zero hypothesis is rejected. This means that, compared to the principle of *random* fixation, the principle of *arranged* fixation has an influence over the quality of the operational process of the milking installation.

3. RESULTS AND DISCUSSION

In Table 3 are presented the results of the processing of the questionnaires and the verification of the null hypothesis for the selected evaluation indicators.

Table -3. Results of the hypothesis test for mean

Evaluative indicators	Sample mean, $\bar{Y}$	Standard deviation, ***S***	Calculated value of ***t***	Warranty probability, ***P***	Evaluation of the null hypothesis, *Ho: E[Y]=μ=0*
Working conditions of the operators-milkmen	1,818	0,404	14,907	3,71E-8	Rejected
Welfare of goats	1,727	0,467	12,264	2,38E-7	Rejected
Productivity level of goats	1,182	0,750	5,221	3,90E-4	Rejected

It is evident from the presented results that for all evaluation indicators the null hypothesis Ho: E[Y] = μ = 0 is rejected, i.e. the fixation principle has a significant influence on the quality of the operational process of the milking installation with regard to the indicators "Working conditions of the operators-milkmen", "Welfare of goats" and "Productivity level of goats".

For the three evaluation indicators, the ***t****-criterion* has positive values**.** Therefore, with a risk of error of 5%, it can be argued that the principle of *arranged fixation* has a significant positive impact and helps to improve the quality of the operational process of milking installation.

The results for "Guarantee probability ***P***" and "Standard deviation ***S***" show that, according to the experts, the principle of arranged fixation has the most positive influence (and has the highest degree of consistency in the expert assessments) on the indicator "Working conditions of the operators-milkmen»: ***P = 3.71E-8*** and ***S = 0,404***.

Similar are the results for "Welfare of goats" indicator: ***P = 2.38E-7*** and ***S = 0,467*.**

The least pronounced (and with the lowest degree of consistency in expert assessments) is the influence of the fixation principle on the "Productivity level of goats" indicator: ***P = 3.90E-4*** and ***S = 0,750***. These results are logical in view of the fact that during the experiment the quantitative dependence between the principle of fixation and the level of animal productivity has not been investigated. It should be added here that the study was conducted in two different lactation periods (two consecutive calendar years). Probably the cumulative effect of these circumstances also explains the lower degree of consistency in expert assessments.

4. CONCLUSIONS

The results of the research allow making the following generalizations:

1. The results confirm validity of the working hypothesis that the fixation principle has a significant impact on the quality of operational process of the linear milking installations, side-by-side type.
2. In compare with the principle of random fixation the principle of arranged fixation has a significant positive impact and helps to improve the quality of the operational process of the milking installation.
3. The following qualitative assessment indicators are formulated to evaluate the influence of the fixation principle: "Working conditions of the operators-milkmen", "Welfare of goats" and "Productivity level of goats". The principle of arranged fixation has the most positive influence on the indicator "Working conditions of the operators-milkmen». Similar are the results for "Welfare of goats" indicator. The least pronounced is the influence of the arranged fixation principle on the "Productivity level of goats" indicator.
4. The results of the study are applicable in the comparative expert assessments of fixing systems as well as in the process of creating new constructions of linear milking installations for goats.

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