Significance tests uses in material logistics of food company in aspect of process technology

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Summary. In this paper the problems of beer-can in production of beer, the stage of taking and filling as well as problems of the "disappear" in process technology are considered. The estimation of process quality has been performed on the basis of statistical significance tests.
Key words: food company, technology process, pouring of beer, statistical tests

INTRODUCTION

In logistic systems of production company of technical materials [8, 13, 14, 15] of food [1, 2, 3, 4, 7, 10] or mechanization of agricultural production [10, 11, 12] the procedure of evaluation of the technological and working costs has become more and more useful [16].

Traditional methods of the evaluation of the materials requirement have used the analyses of statistical methods (rule Just-in-time, ABC methods, system of materials planning – PPK) and control of technologically and working process [6, 18].

The objective of this work was to show the possibility of using the statistical significance tests in production of beer as the component of material logistics estimation (magazine and technology). It is an attempt at quantity estimation of their significance at the specific level of a company.

MATERIAL AND METHODS

The object was the estimation of beer-can "disappear" in time of process technology process at their taking and filling in aspect of the time of the highest demand of consumption.

The methods took into account:

– Tests of zero hypotheses for variables: taking of beer-can (p.p.), filling of beer-can (n.p.) and beer-can "disappear",
– Total statistical calculation of variables,
– Analysis of variance,
– Multiple tests of Tukey, with confidence interwal of 95%

In the test calculations there were used: the t-student test, sign test and test of ranked sign [20].

Results of calculations:

1. The testing of zero hypothesis and total statistic of variables.

The calculations for p.p. variable in the range of level for factor "group" (month) is shown in Table 1.

The calculations for n.p. variable in the range of level for factor "group" (month) is shown in Table 2.

Table 1. The total statistic for p.p.variable

Contents	Variable– p.p.					
	Number	Mean	Standard deviation	Min	Max	Coefficient of variability
1	20	98614.0	7871.70	75410.0	106660.0	7.98
2	16	99501.3	11270.60	60980.0	113600.0	11.32
3	21	101910.0	7448.90	83787.0	112320.0	7.30
4	22	96302.3	14022.50	54470.0	114280.0	14.56
5	22	104400.0	14009.70	64860.0	125680.0	13.41
6	19	106323.0	30158.70	13140.0	173180.0	28.36
Total	120	101167.0	15945.60	13140.0	173180.0	15.76

Table 2. The total statistic for n.p. variable

Contents	Variable – n.p.					
	Number	Mean	Standard deviation	Min	Max	Coefficient of variability
1	20	9872.0	7848.00	75144.0	106296.0	7.98
2	16	99162.0	11237.30	60768.0	113280.0	11.33
3	21	101404.0	7480.18	83208.0	111860.0	7.37
4	22	95946.5	13997.40	54264.0	113928.0	14.58
5	22	404113.0	13970.30	64680.0	125328.0	13.41
6	19	112118.0	20472.60	84696.0	172656.0	18.25
Total	120	101776.0	13962.30	54264.0	172656.0	13.71

In the Table 3 the results for variable „disappear" is presented.

Table 3. The total statistic for „disappear" variable

Contents	Variable – „disappear"					
	Number	Mean	Standard deviation	Min	Max	Coefficient of variability
1	20	342.20	57.07	264.0	504.0	16.67
2	16	339.25	50.58	212.0	434.0	14.91
3	21	509.90	178.27	240.0	950.0	34.96
4	22	351.60	85.34	160.0	478.0	24.27
5	22	322.00	102.67	180.0	708.0	30.92
6	19	410.31	87.24	272.0	576.0	21.26
Total	120	381.80	120.99	160.0	950.0	31.69

2. The analysis of variance and Tukey HSD test.
   The calculations for p.p. and n.p. variables in the range of level for factor "group" (month) is shown in Table 4.

Table 4. The analysis of variance for n.p. and p.p. variable

Content	Sum of square		Degree of freedom		Mean of square		Test F		Significance level	
	p.p.	n.p.	p.p.	n.p.	p.p.	n.p.	p.p.	n.p.	p.p.	n.p.
Between group	1.4E9	3.2E9	5	5	2.9E8	6.5E8	1.14	3.72	0.32	0.037
Inside group	2.8E10	1.9E9	114	114	2.5E8	1.7E8	-	-	-	-

Results of Tukey test for p.p. and n.p. variables was presented in Table 5a and 5b

Table 5a. Results of Tukey test for p.p. and n.p. variables

Method: 95% interwal confidence of HSD Tukey'a						
Contents	Number		mean		Homogenity group	
	p.p.	n.p.	p.p.	n.p.	p.p.	n.p.
4	22	22	96302.3	95946.5	x	x
1	20	20	98614.0	98272.0	x	x
2	16	16	99501.3	99162.0	x	xx
3	21	21	101910.0	101404.0	x	xx
5	22	22	104400.0	104113.0	x	xx
6	19	19	106323.0	112118.0	x	x

Table 5b. Results of Tukey test for p.p. and n.p. variables according to factors level „group" and LSD

Contrast group	Difference		+/- Limit of LSD	
	p.p.	n.p.	p.p.	n.p.
1-2	887.25	890.00	15487.0	12858.4
1-3	3295.52	3132.38	14398.4	11977.8
1-4	2311.75	2325.45	14237.9	11844.3
1-5	5785.55	5841.00	14237.9	11844.3
1-6	7709.16	13846.10	14763.5	12281.5

2-3	2408.27	2242.38	15292.5	12721.6
2-4	3198.98	3215.45	15141.5	12595.9
2-5	4898.30	4951.00	15141.5	12595.9
2-6	6821.91	12956.10	15636.7	13007.9
3-4	5607.25	5457.84	14059.2	11695.6
3-5	2490.02	2708.62	14059.2	11695.6
3-6	4413.63	10713.70	14591.2	12138.2
4-5	8097.27	8166.45	13894.8	11558.8
4-6	10020.90	16171.60	14432.8	12006.4
5-6	1923.61	8005.11	14432.8	12006.4

The results for "disappear" variable is shown in Table 7a and 7b.

The analysis of equipment, material and production of beer on the basis of significance test was performed.

The statistic results that the nominal capacity uses of pouring line(160 00 pcs per day) e.g. in first day – June (group 1) was exploited in minimum value of 47.13% of their possibility. The maximum day uses in June amount 66.66%. In the next month (group 2) the results were 38.13%, 71.00%, respectively. In the whole period of studies (group 1 – group 2) the lowest (8.2%) and the highest (108.2%) day uses were recorded, the highest use option achieved in December. The coefficient of variability amounts to 28.36%. This value is lower than the highest values (28.36%) achieved in November.

The calculations of next production phase for n.p. showed that e.g. in June the minimum value amounted to 94.7% and the maximum to 99.6% in relation to the number of beer-can taking (p.p.).

In the whole month – June the coefficient amounted to 98.8% at 13.77% of variability coefficient.

The information presented in Table 3, concerning the variable "disppear" of beer-can after filling (n.p.) shows large diversifications in the number of carried out studies.

The nominal value of month "disappear" amounted to160 pcs (October) and the maximum value amounted to 950 pcs (August). As to losses in the final product, they resulted from objective reasons (leakiness, deformation, little pour l) and others. As practice shows, 475 liters of beer goes to sewage.

The analysis of variance for p.p. and factor "group" and Tukey test showed that there are the homogeneity group without significance statistical difference (Tab. 5a). However, for n.p. there are homogeneity group (Tab. 5b). Tables 6 and 7a show that the values of variable "disappear" are differential monthly. The difference between June – August and July – August showed two homogeneity groups.

Table 6. The analysis of variance for variable "disappear" and level factor "group"

Content	Sum of square	Degree of freedom	Mean of square	Test F	Significance level
Between group	494986.0	5	98997.2	9.05	0.000
Inside group	1.24E6	114	10940.9	-	-
Total	1.74E6	119	-	-	-

Table 7a. Tukey test for the variable "disappear" and level factor "group"

Contents	Number	Mean	Homogenity group
5	22	332.00	x
2	16	339.25	x
1	20	342.20	x
4	22	351.63	x
6	19	410.31	x
3	21	509.90	x

Table 7b. Tukey test for the variable "disappear" and level factor "group" for LSD

No.	Contrast „group"	Difference	+/- Limits LSD	No.	Contrast „group"	Difference	+/- Limits LSD
1	1-2	2.95	101.69	9	2-6	71.06	10.87
2	1-3	167.70	94.72	10	3-4	158.26	82.49
3	1-4	9.43	93.67	11	3-5	177.90	92.49
4	1-5	10.20	93.67	12	3-6	99.59	95.99
5	1-6	68.11	97.13	13	4-5	19.63	91.41
6	2-3	170.65	100.61	14	4-6	58.67	94.95
7	2-4	12.38	99.61	15	5-6	78.31	94.95
8	2-5	7.25	99.61	-	-	-	-

CONCLUSIONS

Results of researches, which were limited in this paper, showed the significant possibility of uses in the company of the technical standards of beer-can production at no remittent popularity on the market of wrapping.

The difference between the number of beer-can in day production and after filling, so called "disappear" amounted to 950 pcs. It showed the necessity of production of the highest quality beer-cans from the producer as well as strict formality of standards in pasteurization process as well as proper control of their filling. The coefficient of variability for variable "disappear" amounted to 34.96% (August). The average values amounted to 31.69%.

The research will be continued in the next period of production. The information has been particularly subject to analysis, especially that so far there have been no numerous published papers in this range, and the existing articles have presented the information only on the process of technology in range of biological and chemical changes or the description of a particular machine and its technical and technological aspects [9, 17].

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ZASTOSOWANIE TESTÓW ISTOTNOŚCI W LOGISTYCE MATERIAŁOWEJ PRZEDSIĘBIORSTWA SPOŻYWCZEGO W ASPEKCIE PROCESU TECHNOLOGICZNEGO PRODUKCJI

Streszczenie: W artykule przedstawiono problemy związane z puszkami do piwa w produkcji piwa na etapie podnoszenia i napełniania, a także problemy związane ze „znikaniem" w procesie technologicznym. Ocena jakości procesu została przeprowadzona w oparciu o testy statystyczne.

Słowa kluczowe: firma spożywcza, proces technologiczny, nalewanie piwa, testy statystyczne