Аннотация

В статье рассмотрены преимущества и недостатки существующих методов идентификации дефектов скорлупы куриных яиц. В настоящее время для оценки качества скорлупы яиц используется механические измерения, оптико – электронные методы, акустический метод и органолептические методы. Предложенные методы обладают рядом недостатков, одним из которых является необходимость нарушение целостности скорлупы. Перспективным направлением является исследование и разработка бесконтактных методов определения дефектов скорлупы яиц с применением оптико-электронных средств идентификации дефектов скорлупы влияющих на выводимость яиц и на качество столовых яиц.

Ключевые слова: метод, идентификация, скорлупа, яйцо, дефект, трещина, грязь, кровь, овоскопирование, прибор.

Кулмахамбетова А.Т., Алиханов Д.М.

Қазақ ұлттық аграрлық университеті, Алматы

ЖҰМЫРТҚА ҚАБЫРШЫҒЫНЫҢ АҚАУЛАРЫН СӘЙКЕСТЕНДІРУ ӘДІСТЕРІ

Аннотация

Мақалада тауық жұмыртқалары қабыршықтарының ақауларын сәйкестендіру әдістері, сонымен қатар олардың артықшылықтары мен кемшіліктері қарастырылған. Қазіргі таңда жұмыртқа қабыршығының сапасын анықтаудың негізінен үш әдісі қолданылады: механикалық өлшеу, спектроскопиялық өлшеу, органолептикалық әдістер. Ұсынылған әдістер бірқатар кемшіліктерге ие, олардың бірі қабыршық бүтіндігін бұзу қажеттілігі. Жұмыртқалар шығарылымына және азықтық жұмыртқалар сапасына әсер ететін қабыршық ақауларын сәйкестендіруге арналған оптикалық – электрондық құралдарды қолданумен жұмыртқалар қабыршығы ақауларын анықтаудың жанасусыз әдістерін зерттеу және әзірлеу перспективті бағыт болып табылады.

Кілт сөздер: әдіс, сәйкестендіру, қабыршық, жұмыртқа, ақау, жарықтар, ластану, құрал.

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Moldazhanov A.K., Alikhanov D.M., Kulmakhambetova A.T.

Kazakh National Agrarian University, Almaty

THE SUBSTANTIATION OF THE METHOD FOR DETERMINATION OF THE EGG DENSITY BY INDIRECT METHOD

Annotation

In the article considered methods of determination of egg density by direct and indirect way. For substantiate the reliability of the indirect method for determining egg density carried out experimental studies of the size-mass characteristics of eggs by hand and using an automated optic-electronic installation.

Researches have shown that the most accurate calculation of the indirect density is made through the indirect volume and the measured mass, the average absolute error was 0.017 g / cm^3 compared to direct measurements. In this case, the time taken to determine the density of one egg is 15 seconds, which is 6 times faster than the direct method using a hydrometer.

Key words: eggs, incubation, density, volume, dimensions, eggs area, stationary automated installation, sorting machine, productivity.

Introduction

An egg represents the egg cell of a bird supplied with nutrients. The vitellus is formed in the ovaries - the yolk, and the protein and the shell are formed in the oviduct. Thus, the quality of the yolk (mass, density, consistency), that forms before a thorough egg formation, is affected by the feeding ration and the conditions of poultry management. In the chicken eggs the protein is 56-58% and its average density is 1,045 g/cm^3, yolk is 30-32%, the average density is 1,028 g/cm^3, the shell is 10-14% of the total weight, the average shell density is 1.5 g/cm^3. Their ratio and density for different crosses of chickens are different, and it also depends on the conditions of the poultry management. Each component of the egg has its own density, which can be different for each egg that affects the incubation and quality of the marketable egg. For example, eggs with a high density of the shell are unsuitable for incubation because they do not pass nutrients and air to the embryo. Eggs with a low density of protein have a low nutritional value. Thus, the density of the egg characterizes its freshness and the thickness of the shell, whereby it is an indispensable indicator of the quality of both hatching and marketable eggs.

A fresh full-fledged egg has a density of 1.085-1.1 g/cm^3 or more. According to sanitary and hygienic requirements hatching eggs should have the following density for successful incubation: of not less productivity than 1.08 g/cm^3 for hens for the purpose of farming eggs and not less than 1.075 g/cm^3 for the purpose of farming meat. Eggs with a low density reduce hatchability to 17% [1].

Before determining the egg density by a direct method, salt brines of various concentrations are created using a hydrometer. If the egg, immersed in one of the solutions, is in a suspension state (does not sink and does not float), then its density corresponds to the density of the solution.

Density is also determined by another method: two-fold weighing of the egg (or the whole egg sample) first in the usual way, and then in distilled water at a temperature of 20 °. The difference between the parameters of these values is equal to the volume of the egg (cm^3), and the mass (in air) divided into the volume gives the egg density (g / cm^3) [2].

Thus, the process of determining the density of eggs is laborious and takes considerable time when sorting eggs, so in the poultry plants it is not important to determine the density of all eggs, but those for the control lot.

Materials and research methods

The eggs of the cross "Loman-White" were taken as the test material in different masses and in a quantity of 60 pieces, stored for not more than 3 days.

The experiment was conducted in several stages. First, all the eggs were weighed on the DX-240 laboratory scales with an accuracy of 0.01 g, Figure 1.

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Figure 1 – Weighing eggs on the DX-240h scales

After that, the volume of the egg was determined. It was determined with the help of measuring flask with a division value of 0.1 cubic centimeter by a direct method according to Archimede's principle, Figure 2.

Figure 2 – Determination of egg volume according to Archimede's principle

At the third stage of the experiment, containers with different strengths of salt brine were prepared in the range from 1.07 to 1.10 g/cm^3 with a division interval of 0.00025 g / cm^3, the density of the solution was measured by the hydrometer, Figure 3.

Figure 3 – Salt brine with a density of 1,085 g/cm^3

The density of each egg is determined by the consequetive immersion of eggs in the salt brines of different density.

The geometric parameters of eggs (S, L, D, d) on a stationary electrooptical installation, which consists of a video capture device (digital camera) mounted on a tripod, a personal computer with a developed capture program and analysis of images and a black matte surface on which an egg is mounted. [3].

Attained results are included in the table for subsequent calculations and statistical processing.

Thus, according to the geometric parameters of the egg, the mass of eggs is determined indirectly using the formula proposed in [4]:

$$m = 0.0399 * \mathrm{S} - 15.166, g \quad (1)$$

here m – a mass of the egg; $\mathrm{S}-$ an area of longitudinal section of the egg;

To determine the volume by an indirect method, the formula proposed in was used [5]:

$$V_{sd} = 0.641 * S * d, \text{ cm}^3 \quad (2)$$

here V_{sd} – a volume of the egg; $\mathrm{S}-$ an area of longitudinal section of the egg; d – a small diameter of the egg.

According to the results, calculations of the egg density were made by indirect means, the indirect egg volume through experimental measurements of weight and measured egg volume through the indirect mass:

$$\rho_v = \frac{m}{Vsd}, \text{ g/cm}^3 \quad (3)$$

$$\rho_m = \frac{mk}{V}, \text{ g/cm}^3 \quad (4)$$

All the attained results are verified and it was figured out the absolute error for each method of density measurement in comparison with the real density of eggs.

The attained results are processed by methods of variational statistics in the program Statistica 12.

Research results

Based on the results of the experimental study, the values of mass, volume and the egg density were measured, the scale of longitudinal section, perimeter, large and small diameter of eggs and also their shape coefficient were measured on an automated electrooptical installation. By direct method using a hydrometer, time taken to measuring the density of 60 eggs was 90 minutes.

Time spent for determination of the indirect density of 60 eggs using an electrooptical installation was 15 minutes.

On the basis of the proposed formulas 1 and 2, the indirect values of the mass and volume the of the egg are calculated, and also obtained the values of the reference density the measured mass (M) through the indirect volume (V_{sd}) and the measured volume (V) through the indirect mass (M_k), table 2

Table 2 – Results of indirect determination of density in comparison with measured one.

Measured values				Indirect values				Absolute error	
№	M	V	p	M_k	V_{sd}	p_v	p_m	$p-p_m$	$p-p_v$
1	54,62	50,1	1,0900	56,10	50,51	1,1198	1,0814	0,030	0,009
2	57,00	52,5	1,0850	58,52	52,13	1,1147	1,0935	0,030	0,009
3	57,24	53,0	1,0800	59,13	52,57	1,1157	1,0889	0,036	0,009
4	57,44	53,6	1,0725	60,41	53,56	1,1270	1,0724	0,054	0,000
5	58,16	53,4	1,0900	59,56	53,13	1,1153	1,0947	0,025	0,005
6	58,51	54,2	1,0800	60,04	53,20	1,1077	1,0999	0,028	0,020
7	58,57	53,6	1,0920	60,08	53,90	1,1209	1,0867	0,029	0,005
8	58,60	54,0	1,0850	59,06	53,31	1,0938	1,0991	0,009	0,014
9	58,79	54,6	1,0775	60,07	52,71	1,1002	1,1153	0,023	0,038
10	59,04	54,6	1,0800	60,85	54,06	1,1145	1,0921	0,035	0,012
11	59,36	54,9	1,0825	60,40	53,14	1,1001	1,1171	0,018	0,035
12	59,37	54,3	1,0925	60,43	54,08	1,1129	1,0979	0,020	0,005
13	59,39	55,0	1,0800	61,24	53,15	1,1135	1,1174	0,033	0,037
14	59,43	55,0	1,0825	60,97	53,58	1,1085	1,1092	0,026	0,027
15	59,77	55,1	1,0850	60,78	54,55	1,1030	1,0958	0,018	0,011
16	60,12	55,5	1,0825	61,16	53,45	1,1020	1,1248	0,019	0,042
17	60,32	56,2	1,0750	60,30	54,99	1,0730	1,0970	0,002	0,022
18	60,47	55,7	1,0850	61,75	54,17	1,1087	1,1163	0,024	0,031
19	60,57	55,2	1,0950	60,84	54,03	1,1022	1,1211	0,007	0,026
20	60,58	55,8	1,0850	61,11	55,84	1,0952	1,0848	0,010	0,00001
21	60,67	56,1	1,0800	62,27	55,34	1,1100	1,0964	0,030	0,016
22	60,78	55,6	1,0925	62,70	55,63	1,1276	1,0926	0,035	0,00001
23	61,12	56,6	1,0800	61,77	55,40	1,0913	1,1033	0,011	0,023

24	61,32	56,6	1,0825	62,78	55,71	1,1091	1,1007	0,027	0,018
25	61,38	56,4	1,0875	63,40	56,40	1,1241	1,0882	0,037	0,001
26	61,47	56,3	1,0925	61,73	55,20	1,0964	1,1135	0,004	0,021
27	61,51	56,8	1,0825	62,32	55,65	1,0972	1,1052	0,015	0,023
28	61,69	56,5	1,0925	61,98	55,40	1,0970	1,1136	0,004	0,021
29	61,72	56,9	1,0850	62,34	56,15	1,0955	1,0992	0,011	0,014
30	61,89	57,0	1,0850	62,27	56,42	1,0925	1,0969	0,007	0,012
31	62,08	57,4	1,0800	63,93	56,96	1,1137	1,0898	0,034	0,010
32	62,64	57,4	1,0900	62,79	57,11	1,0938	1,0969	0,004	0,007
33	62,96	58,1	1,0850	63,41	57,04	1,0915	1,1039	0,006	0,019
34	63,00	58,0	1,0800	64,86	56,75	1,1183	1,1101	0,038	0,030
35	63,52	58,7	1,0825	63,46	57,64	1,0811	1,1020	0,001	0,020
36	64,20	59,2	1,0850	65,25	57,19	1,1022	1,1226	0,017	0,038
37	65,00	59,5	1,0925	64,08	58,03	1,0769	1,1202	0,016	0,028
38	65,03	60,0	1,0850	64,74	58,63	1,0790	1,1091	0,006	0,024
39	65,50	60,5	1,0825	66,97	59,75	1,1069	1,0963	0,024	0,014
40	66,18	61,0	1,0850	66,38	59,75	1,0882	1,1076	0,003	0,023
41	66,32	61,0	1,0850	65,30	59,94	1,0705	1,1064	0,014	0,021
42	67,65	63,1	1,0725	68,36	61,35	1,0833	1,1026	0,011	0,030
43	68,33	62,9	1,0875	68,51	62,14	1,0892	1,0996	0,002	0,012
44	68,73	63,4	1,0850	69,53	61,81	1,0966	1,1120	0,012	0,027
45	69,04	64,3	1,0750	68,40	62,36	1,0637	1,1071	0,011	0,032
46	70,08	65,0	1,0800	69,82	63,42	1,0742	1,1050	0,006	0,025
47	70,15	64,6	1,0850	70,09	63,74	1,0850	1,1006	0,00002	0,016
48	70,19	65,0	1,0800	69,47	63,45	1,0688	1,1062	0,011	0,026
49	70,19	64,7	1,0850	69,51	64,44	1,0743	1,0891	0,011	0,004
50	70,36	65,1	1,0825	69,22	64,54	1,0634	1,0903	0,019	0,008
51	70,65	65,3	1,0800	71,59	63,83	1,0964	1,1069	0,016	0,027
52	71,12	66,0	1,0800	70,18	66,11	1,0634	1,0758	0,017	0,004
53	71,63	66,7	1,0775	70,07	65,74	1,0505	1,0896	0,027	0,012
54	72,02	66,6	1,0800	70,76	66,56	1,0625	1,0821	0,018	0,002
55	72,12	66,5	1,0850	70,07	66,88	1,0537	1,0783	0,031	0,007
56	72,51	67,1	1,0800	72,58	66,11	1,0817	1,0969	0,002	0,017
57	73,26	67,8	1,0800	71,70	67,29	1,0575	1,0888	0,022	0,009
58	73,39	67,7	1,0850	71,66	67,26	1,0585	1,0912	0,026	0,006
59	74,44	69,0	1,0800	75,06	68,42	1,0878	1,0880	0,008	0,008
60	78,00	71,8	1,0850	77,25	72,29	1,0759	1,0790	0,009	0,006

Based on the results of the obtained values, the statistical processing of the data was carried out, as the result of which it was revealed that the minimum absolute error of the indirect density values through the calculated mass was 0.00002 g / cm^3, the maximum was 0.054 g / cm^3, the average value was 0.018 g / cm^3. The values of the minimum absolute error of the indirect density values through the calculated volume were 0.00001 g/cm^3, a maximum of 0.042 g/cm^3 and an average value of 0.016 g/cm^3 in comparison with the measured data.

As it is apparently seen in attained results, the calculation of the indirect density through the measured mass and calculated volume give more accurate density results. Thus, the optimal density determination formula by an indirect method will be:

$$\rho_v = \frac{m}{Vsd} = \frac{m}{0.641*S*d}, \text{ g/cm}^3 \quad (5)$$

here m – a measured mass; S – an area of longitudinal section of the egg; d – a small diameter of the egg;

Conclusion

The following conclusions can be drawn from the results of the research:

1. Time to determine the density of 60 eggs with the indirect means using an electrooptical installation is 15 minutes or 15 seconds per egg, which is 6 times faster than a direct method using a hydrometer.

2. Experimental measurements of the volume of 60 eggs by a manual method using the measuring flask and the hydrometer were carried out, and a mathematical calculation of the density of those eggs was carried out in two ways: an indirect volume - a measured mass and an indirect mass - the volume measured by five known formulas. The results of comparison of calculated density values showed that the most accurate calculation of the indirect density is made through an indirect volume and the measured mass, the average absolute error was 0.017 g / cm^3.

3. The experimental researches that are carried out on the automated installation allowed to determine the values of the area and perimeter of each egg. The obtained values are used to calculate the indirect value of the volume in the proposed method and the density through the measured mass and the indirect value of the volume. A formula for determining the indirect density value is proposed:

$$\rho_v = \frac{m}{Vsd} = \frac{m}{0.641*S*d}, \text{ g/cm}^3$$

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Молдажанов А.К., Алиханов Д.М., Кулмахамбетова А.Т.

Казахский национальный аграрный университет

ОБОСНОВАНИЕ МЕТОДА ОПРЕДЕЛЕНИЯ ПЛОТНОСТИ ЯИЦ КОСВЕННЫМ СПОСОБОМ

Аннотация

В статье рассмотрены методы определения плотности яйца прямым и косвенным способом. Для обоснования достоверности косвенного метода определения плотности яйца проведены экспериментальные исследования размерно-массовых характеристик яиц ручным способом и с использованием автоматизированной оптико-электронной установки.

Исследования показли что, наиболее точный расчет косвенной плотности производится через косвенный объем и измеренную массу, средняя абсолютная погрешность составила 0,017 г/см^3 по сравнению с прямыми измерениями. При этом время, затраченное на определение плотности одного яйца, составляет 15 секунд, что в 6 раз быстрей прямого способа с использованием ареометра.

Ключевые слова: яйца, инкубация, плотность, объем, размеры, площадь яиц, стационарная автоматическая установка, сортировочная машина, производительность.

Молдажанов А.К., Алиханов Д.М., Кулмахамбетова А.Т.

Қазақ ұлттық аграрлық университеті

ЖҰМЫРТҚА ТЫҒЫЗДЫҒЫН ЖАНАМА ТӘСІЛІМЕН АНЫҚТАУ ӘДІСІН НЕГІЗДЕУ

Аннотация

Мақалада жұмыртқа тығыздығын тікелей және жанама тәсілімен анықтау әдістері қарастырылған. Жұмыртқа тығыздығын жанама әдіспен анықтау нақтылығын негіздеу үшін жұмыртқалардың өлшемдік – салмақтық сипаттамаларына қол әдісімен және автоматтандырылған оптико – электронды қондырғыны қолданумен эксперименттті зерттеулер жүргізілді.

Зерттеулер жанама тығыздықтың дәл есептемесі жанама көлем мен өлшенген салмағы арқылы шығарылатындығын көрсетті, орташа абсолютті қателік тікелей өлшеу әдісімен салыстырғанда 0,017 г/см^3 құрады. Сонымен қатар, бір жұмыртқа тығыздығын анықтауға кеткен уақыт 15 секунд, яғни ареометр қолданылатын тікелей әдістен 6 есе жылдам.

Кілт сөздер: жұмыртқалар, инкубация, тығыздық, көлем, өлшемдер, жұмыртқа ауданы, стационарлық автоматты қондырғы, сұрыптау машина, өнімділік.