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METHODS FOR IDENTIFICATION OF EGG SHELL DEFECTS

Annotation

The article considers the advantages and disadvantages of the existing methods for identifying eggshell defects. At present, mechanical measurements, optical-electronic, acoustic and organoleptic methods are used to assess the quality of eggshells. The proposed methods have a number of drawbacks, one of which is the need to disrupt the integrity of the shell. A promising direction is the research and development of non-contact methods for the determination of eggshell defects with the use of optical-electronic means for identifying shell defects affecting the hatchability of eggs and the quality of commercial eggs.

Key words: method, identification, shell, egg, defect, crack, dirt, blood, ovoscoping, appliance.

Introduction

One of the main branches of the country's agro-industrial complex is poultry farming. Currently, Kazakhstan's poultry farms produce over 3 billion eggs per year, which provides more than 30% of the population's demand for natural food products of animal origin [1]. With the aim of providing the population with products of the poultry industry, technological processes are constantly being improved. which are aimed at improving the quality of the selection of both incubation and commercial eggs, withdrawal from the hatchery, feeding, providing microclimate in poultry houses and etc.

The high quality of eggs is one of the most basic conditions that ensure good incubation results, therefore in hatcheries it is necessary to evaluate them carefully. First of all, we must pay attention to the shell, since it is the main anatomical component of the egg, which determines its integrity, stability of the composition and sufficient protection against unfavorable environmental factors. [2]

During the last 50 years, researches are constantly being conducted on the study of the egg shell, and in particular the factors that affect its quality. Decreasing the quality of the shell can be a great problem, causing significant losses to poultry farms that produce an industrial commercial egg. Its seriousness is often underestimated due to the fact that the quantity of eggs with a notch and the broken ones significantly increase during transportation and packaging. The economic losses for the enterprises engaged in the production of the hatching egg are even more serious, since the hatchability and safety of daily chickens is reduced.

Thus, further improvement of existing methods, development of new express methods and instruments, which help to determine the quality indicators of eggshells is an actual problem in the field of poultry farming.

Material of research

The material of the researching are methods and technical means for determining the quality of the egg shell. The egg shell is a solid natural shell, which covers the softer internal, as fertilized (fetus) and not fertilized parts of the egg (protein and yolk). Thus, the shell protects the chick embryo from external factors that affect its development, and also creates an internal microclimate with useful elements of nutrition. In commercial eggs, the shell is a cover for protein and yolk, thereby preserving the quality of eggs for a certain time, and also does not allow the contents to leak. The shell consists of 98% calcium carbonate and 2% of the salts of phosphorus, magnesium and an organic substance that binds these salts [3].

During storage, especially in inadequate conditions, as well as during transportation and for a number of other reasons, some defects appear in the eggs. The eggs that have defects are classified as food or technical defective, depending on the type of defect and the degree of its development. Defects include eggs with damaged shells: incisions in which the egg shell is cracked without damaging the inner shell of the egg, as well as crumpled sides - eggs with a partially crumpled shell and also without any damage under the shells. The marbling of the shell is the heterogeneity of its structure in terms of thickness and porosity. Its individual sections have a high porosity with a thinner shell. In these areas, moisture accumulates, which gives a mottled appearance. The main disadvantage is the roughness of the shell. It is easily determined and with an external examination, and with the palpation of the egg. More often the roughness is observed on the sharp or blunt ends of the egg as a continuous cluster of small tubercles. The shell is usually very thin in this place. A large number of large pores are located around the tubercles and between them. This leads to profound disturbances in water metabolism in eggs, increased mortality of embryos, and the hatchability of weak chickens.

Review of existing methods for the identification of eggshells

Eggs are selected for incubation by evaluating them in appearance and in translucence. Eggs with different deviations on the quality of the shell have reduced hatchability. Table 1 presents data on the effect of various shell defects on hatchability [4].

Table 1- Effects of shell defects on hatchability

Types of egg defects	Hatchability %
With a polluted shell	58-63
With violation of the integrity of the shell	37-45
Irregularly shaped	45-52
With a roughness of shell	52-60
With outgrowths on the shell	48-56
With thin shell	44-51
With marble shell	65-73
With a large or movable air chamber	37-53
With ragged hailstones	46-54
Eggs are standard in quality	89-92

From the data given in Table 1, it follows that the following defects have a significant effect on hatchability: violation of the integrity of the shell, irregular shape, marbling, roughness and outgrowths on the shell. By detecting and rejecting hatching eggs with shell defects, hatchability can be improved. At present, a number of indirect methods are used to determine the quality of the shell. Determination of the strength associated with the shell thickness on density of eggs is based on a significant difference between the density of the shell (average 2.4 g / cm3) and the density of the contents of the egg (close to 1 g / cm3). The density is determined by dropping fresh eggs into a salt solution of a certain concentration (usually 1.050, 1.075, 1.090). At 20° C and 60-70% relative humidity of the air density of the eggs reduces very quickly. During the first day of storage, the density of eggs decreases by 0.003-0.004 g / cm3 [4].

The value of elastic deformation is characterized by the amount of deflection of the shell area under the influence of a certain weight (500 g). To determine the elastic deformation is used a special device PUD-1. The egg is placed on a special table on the device, a micro-indicator is brought into contact with it and further affects the surface of the egg by the force of 500 g, while the shell is deformed. When the shell load is removed, it assumes its original position again. The arrow of the micro-indicator fixes the degree of deformation of the egg. The more a shell bends under the weight , the thinner it is. The measurements are carried out in one

day after the laing eggs, for the shell is not strong enough the first day and the readings may be incorrect. It is impossible to measure elastic deformation on eggs with a notch of the shell.

Elastic deformation of the shell characterizes its thickness. The greater the deformation of eggs, the thinner is the shell [5].

The strength of the shell related to the breaking of eggs leads to very significant economic losses, in the poultry farms and trade organizations. Eggs with damaged shells (there are up to 15% of such cases) can not be stored, incubated, they are dangerous to health when consumed. Therefore, in every poultry farm, in order to reduce breaking, a systematic control of the strength of the shell is conducted. Precisely to judge the strength of the shell is possible only on the basis of its direct measurement, which is carried out in three main ways [6]:

1. Compression (crushing) eggs under pressure of a certain force, expressed in kgf or in newtons (H). On the long axis the egg can withstand 3 kgf (about 30 N) and more.

2. Puncture the shell with a thin stem or needle with a cut end. The force at the moment of puncture is recorded in kgs or N.

3. Impact on the shell (collision) is the most typical case of its damage when moving eggs from the layer to the consumer. Impact (instantaneous) forces are hundreds and thousands times greater than static ones (pressures). The egg breaks, colliding with another egg or striking against a hard object when falling from a height of only 1 cm; in both cases the speed before impact may be less than 0.5 m / s [6].

There is a device PPSU - 3 for measuring the strength of the shell. The strength of the shell is expressed in points on a six-point scale, while the egg that crashed when the rod fell from the height of the first step receives 1 point of strength, the second ones gets 2 points, from the sixth has 6 points. The average shell strength for the egg sample is calculated to within 0.01 points. The blows are made along the "equator" of the egg. Studies have shown that in 60% of the cases the shell is damaged precisely in the region of the "equator" (on the acute pole - 24% of damage, on the other - 16%) [6].

The porosity of the shell is determined by counting pores at a certain area in the zone of blunt, sharp ends and the middle of the egg. Porosity of the shell plays an important role in the respiratory and water metabolism of embryos. The pores are counted by their coloring with methylene blue or other dyes. For this purpose, it is necessary to open the egg, remove the contents. In separate sections of the shell, with a special template are marked some zones with area of 0.25cm^2 in 4 of squares in the sharp and blunt ends and the middle of the egg. Inside the shell, a 0.2% alcohol solution of methylene blue is pipetted. 10-12 hours are required for the full manifestation of pores. The calculation is carried out on average on each section of the shell according to four measured squares. Absolute permeability of the shell, that is, the number of open and closed pores, is determined in a similar way, but the shell is pre-treated (boiled) in a 10% solution of alkali (sodium hydroxide, caustic potassium, etc.) for 15-20 minutes.

Translucence is the main method of assessing eggs before incubation, it allows us to identify a lot of valuable traits in order to get an idea of the quality of eggs. The shell of a full-fledged egg is translucenced evenly. If it is thin, then in that area it is more translucent. In some parts of the shell, one can see light spots of different sizes. If there are a lot of them, then the shell in the case of translucence gets a marble look. The very strong marbling of the shell is due to the heterogeneity of its structure and is a serious drawback. Usually such eggs quickly evaporate water, the hatchability from them is low [7]. Also, when translucent you can see small cracks on the shell, this is the so-called notch. Eggs with a notch are not pawn on the incubation, because they can be broken, and the content of eggs will contaminate the neighboring eggs will cause them considerable damage. In addition, a broken egg can be a medium for the development of harmful microorganisms [8].

Based on the translucence of eggs, methods are proposed for determining eggshell defects by multispectral photographing and decomposition of the egg image into light channels. Spanish scientists Loredana Lunadei and Luis Ruiz-Garcia proposed a multispectral installation, shown

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in Figure 1, which allows to capture an image of the egg in infrared light (560 nm) and blue (430-490 nm) [9].

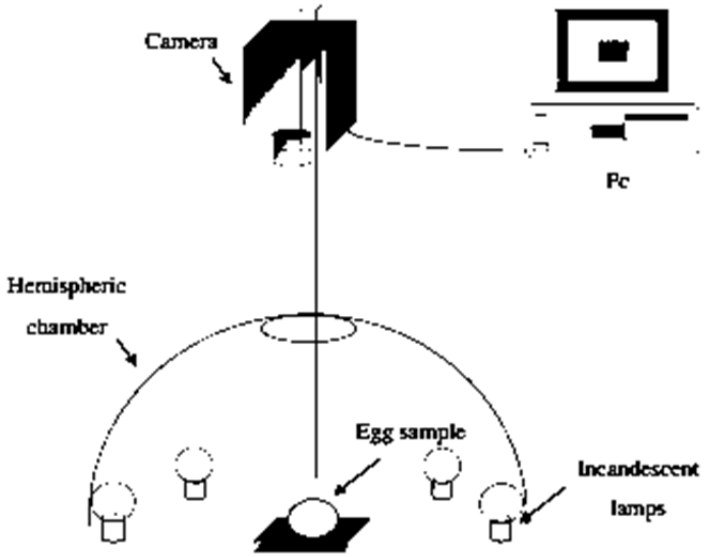

Figure 1 - Scheme of the multispectral camera for the determination of eggshell defects

The essence of the method is as follows: an egg is placed in a special spherical chamber with incandescent lamps, the camera captures the image in R and B color channels, then the resulting image is sent to a computer where in the program developed in MatLab, the blue channel is removed from the red (R-B), with the subsequent binarization of the resulting image, in this way the defective areas on the histogram with the image are detected (the defects have a dark gray color), Fig. 2.

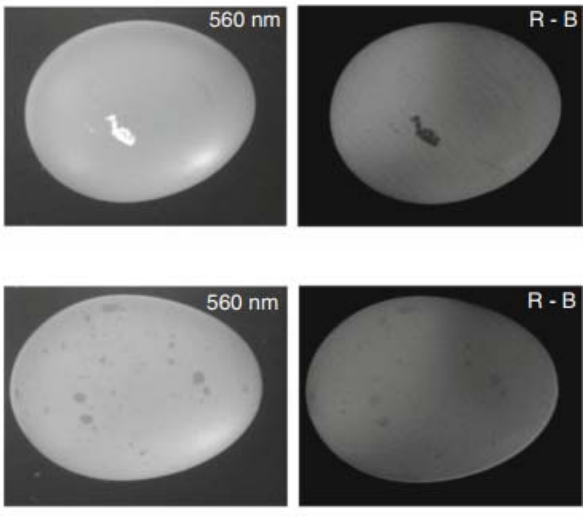

Figure 2 - Digital images obtained at 560 nm (left), R-B images (center) and histograms of R-B images from egg shells of white color.

This method allows to determine such defects as dirt on the shell, blood stains and cracks. The disadvantages of this system is the use of an expensive infrared camera and the inability to detect more than one defect at a time, and the proposed method allows to determine cracks only on eggs with a white shell.

The optical methods are also proposed for determining eggshell defects using Fuzzy logic and artificial intelligence. The essence of the method is to capture the image of the egg and application in the analysis of the egg image of an artificial learning system and image binarization using Fuzzy logic, instead of the standard binarization. The algorithm for determining defective eggs is shown in Figure 3.

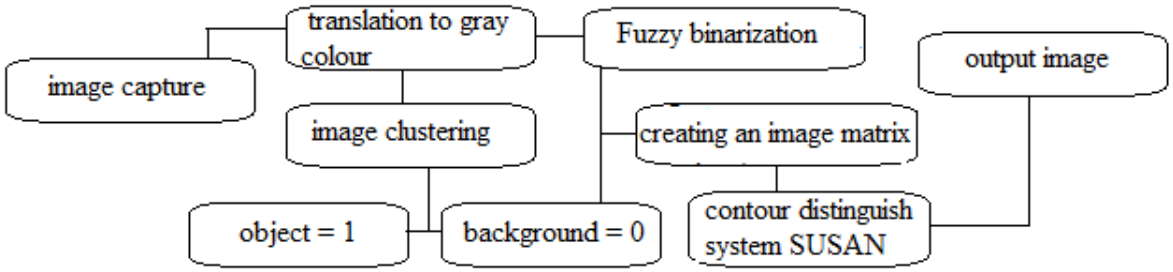

Figure 3 - Algorithm for determining shell defects based on AI and Fuzzy logic.

This method determines with high accuracy the cracks in the egg shell, the average accuracy is 92.8% [10]. Figure 4 shows the result of the determination of a crack using AI.

Figure 4 - Result of the definition of a crack based on the AI SUSAN-detector.

The disadvantage of this method is that the system determines only the crack of the eggshell, the remaining defects are not recognized [10].

In the egg grading machines of various leading companies, such as the Sanovo technology group STAALKAT ARDENTA and MOBA are various methods also used for the determination of shell defects. The main elements of the STAALKAT ARDENTA system for determining shell defects are [11]: an open-leak detection system, the system is equipped with high-resolution cameras, detects eggs with an open leak; Semi-automatic of ovoscoping System with IRUS camera enables the operator to classify products by the presence of shell defects; acoustic method of detecting incisions.

The MOVA egg grading machine also has the functions of identifying eggshell defects [12]. The main subsystems of the MOBA OMNIA for the detection of defects: semi-automatic ovoscope, incision detector. The magnetic-acoustic system is used to detect the most inconspicuous, "hairy" cracks in the egg shell. The mud detector makes it possible to identify various types of dirt. The open leak detector of OMNIA "sees" the open leak, culls it at the initial stage.

A promising direction of improvement of methods for the determination of shell defects is the study and creation of contactless methods for determining eggshell defects with the use of

opto-electronic methods for recognizing various shell defects affecting the hatchability of eggs and the quality of commercial eggs.

Research results

A method for determining eggshell defects using a vision system is proposed. For the operate egg separation system on defective eggs the following algorithm is developed and proposed in Figure 5.

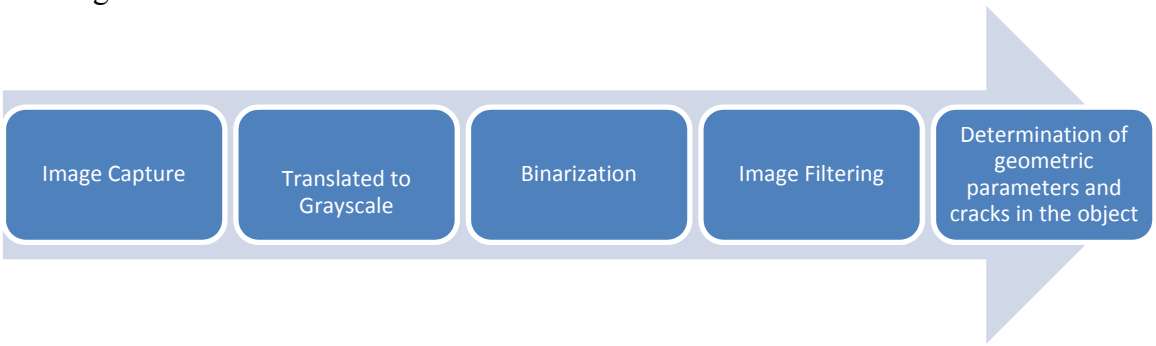

Figure 5 – The algorithm of the program

The essence of the method is as follows, the egg is photographed, after which the captured image is translated into gray and binirized. The resulting black and white image allows to select the background and the egg. The separated image of the egg is analyzed and calculated the dimensions of the shell cracks.

According to the proposed method, an experiment was conducted. The experiment is as follows, cracks of different depths were introduced into the program, and it was checked in what tones the cracks can be recognized by the program.

Based on the experiment, it can be confirmed that the program determines cracks in the range from black to light tones. In this case, the lighter the defect, the greater the error in determining its area, this is due to the fact that the pixels located along the edges of the fissure merge with the background of the egg and lose their brightness.

For cracks in gradations below 30%, in the program "STZ - EGG" it is necessary to exclude the definition of pixels of dark tones and to narrow the color of the definition of eggs to light gray - white tone. The average running time of the program varies from 49 to 73 ms, the time taken to determine the crack from 11.8 to 12.5 ms.

Conclusions

1. The hatchability of healthy chickens from defective incubative eggs is significantly lower. The probability of chick hatching is reduced by 50 percent, because various shell defects such as cracks and porosity of the shell allow moisture, various microbes and bacteria to pass through, leading to the death of embryos, and defects such as marbling and contamination reduce air and heat penetration, which also adversely affects embryonic development of the chick. Therefore, the identification and rejection of eggs with various shell defects before laying on the incubation is the primary and important step for the hatchability of healthy chickens. Penetration of microbes through cracks in commercial eggs, reduces the quality of eggs and leads to the development of pathogenic bacteria in the egg, which is dangerous for the consumer.

2. Existing methods for identifying shell defects use a contact method to identify defects, thereby subjecting the egg to deformation and breaking the shell, which is not acceptable for hatching eggs. Also, a significant drawback of existing methods can be attributed high labor intensity and low productivity in the determination of shell defects. All the proposed methods allow to determine only a control sample from a common lot and do not allow to control the quality of the shell of each egg delivered to the incubation.

3. The most practical application was the method of determining cracks by translucencing of eggs (ovoscoping). This method is based on a visual inspection of eggs that are translucent in

through a powerful light source. The disadvantage of this method is the subjectivity of visual inspection by a person.

4. The existing egg grading machines use optical and acoustic methods for determining eggshell defects. The disadvantage of these machines is their high price, large size and necessity of defected egg removal by hand or half-automatically that demands an additional worker on the sorting line.

5. The more actual and popular methods of determining eggshell defects are based on the optic-electronic one. Such methods allow contactless and in real time to determine the basic defects of the eggshells.

6. For cracks in gradations below 30%, in the program "STZ - EGG" it is necessary to exclude the definition of pixels of dark tones and to narrow the color of the definition of eggs to light gray - white tone. The average running time of the program varies from 49 to 73 ms, the time taken to determine the crack from 11.8 to 12.5 ms.

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МЕТОДЫ ИДЕНТИФИКАЦИИ ДЕФЕКТОВ СКОРЛУПЫ ЯИЦ

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.

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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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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.