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USING ALTERNATIVE REPRESENTATIONS OF THE RGB COLOR MODEL TO SEPARATE ERGOT SCLEROTIA (*CLAVICEPS PURPUREA)* FROM THE IMPORTED WHEAT

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Abstract

Sclerotium of ergot is hard fungal body which contain toxic alkaloids to human and livestock. These alkaloids include ergotamine, ergovaline, ergocornine, ergocryptine, and ergocristine. Consumption of ergot can lead to human harmful health effects. These include constriction of blood flow to extremities, gangrene, hallucinations, muscle spasms and vomiting. Livestock fed ergot sclerotia can develop gangrene symptoms of ears, hooves and tails. The alkaloids can also cause abortions and reduce mammary gland development. The study was carried out through 2019 at the agriculture engineering department, faculty of agriculture Tanta University, Egypt. To prevent the harmful health effects in humans and livestock's using separating methods which depend on physical properties and image analysis software for different varieties of wheat imported to Egypt which contaminated with ergot fungi sclerotia. The average dimensions of ergot fungi sclerotia were ranged according imported place the length ranged from 2.32 to 22.51 mm. width from 0.12 to 2.91 mm. thickness from 0.12 to 2.21 mm. volume from 0.0511 to 65.133 mm^3, geometric mean diameter from 0.46 to 4.98 mm, the arithmetic mean diameter from 1.7 to 9.10 mm, and sphericity, from 7.9 to 55.6%. Also surface area ranged from 0.66 to 78.02 mm^2. On the other hand, the average dimensions of the different varieties of Russian Ukrainian and French wheat were: length 5.24, 5.24, 5.17 mm, width 1.92, 1.92, 2.35 mm, thickness 162, 161, 186 mm, volume 8.81, 8.75, 12.1 mm^3, arithmetic mean diameter 2.52, 2.52, 2.82 mm^2, geometric mean diameter 2.92, 2.92, 3.13 mm^2, sphericity 48.2, 48.1, 57.8%, aspect ratio 36.7, 36.7, 45.9, and surface area 20.3, 20.2, 25.2 mm^2 respectively. These results revealed that the differences between the physical properties of wheat varieties and ergot sclerotia is not strong spicily for length, width and thickness this case led to obstructing separation processes.

Key words**:** *imported wheat, physical, image, properties, and Ergot fungus*

INTRODUCTION

Wheat is one of the most important and strategic crops of the Germaine family member, its source of essential nutrients, providing energy, fiber, carbohydrate, protein, Vitamins, iron, calcium, phosphorus, zinc, potassium and magnesium. the fractionation of the crushed grain during milling has critical implications for the distribution of many nutrients. Ergot of wheat is a plant fungal disease which replaces the grain of the wheat with a hard purplish dark sclerotium produces external spores as mycotoxins infects wild grasses and cereal grains, it can cause 5-10 percent yield losses in small grain cereals such as Wheat, Barely, Millet, and Oats. Untimely forming ergot sclerotia which are generally large and easily visible. The total production of wheat in the world 734 million tonnes, with harvested area 214.29 million ha. on the other hand, the harvested area in Egypt was 1.3 million ha with total production 8.8 million tonnes according to FAO 2018 [4]. The knowledge of the physical, mechanical and aerodynamic properties of agricultural products are necessary and important in design of different component of machines and equipment for processing, handling, separating, cleaning, transporting and storage. [1], [3], [10]. The term Ergot is referred to the

sclerotium of ascomycetes a protective kernel produced during resting stage of some fungi – which replaces seeds of susceptible cereals and plants intended for human and animal diet. It contains various compositions of tryptophan-derived toxins defined ergot alkaloids [8]. Ergot Alkaloids have long been known as toxic compounds with a broad spectrum of adverse effects on human and animal health leading mainly to the Ergotism disease, the alkaloids produced by the fungus severely affect the health of humans and warm-blooded animals [9]. Ergot is typically detected upon visual inspection, with dark sclerotia bodies being up to 10 times larger than grain kernels. However, ergot bodies may range in size from a few millimeters to more than 4 cm depending on the size of the host plant [7].

Concluded that Wheat is one of the most important staple crops in temperate zones and in demand of increasing in industrialization. Also being a major source of starch and energy, it can provide most of essential health protein, B vitamins, dietary fibre, and phytochemicals. the consumption of cereal dietary fibre and reduced risk of cardio-vascular disease [9].

Compared different wheat origins France, Romania, Russia and Ukraine, imported to Egypt, and to check the safety of them to be consumed in Egypt, the Ukrainian wheat was the beast among all other wheat originated from France, Romania and Russia, Ukrainian under different moisture content ranged from 10.88% to 12.43% with an average of 11.46%., test weight, ranged from 78.77 to 80.57 kg hl-1 with an average of 79.70 kg hl-1 and falling number, ranged from 322.0 to 412.0 sec with an average of 360.47 sec., and came in the second order in other tests as, protein content, which ranged from 12.21 to 13.67% with an average 12.80%, broken grains ranged from 0.746 to 1.925% with an average of 1.115%. Ukrainian wheat came in the third order [2].

Using images indices and The ENVI software package to analyze the images of fruits and three bands, RGB, (red, green, blue) were derived for each image until obtaining the R, G, B color then color indices Red/ Green ratio (R/G), hue, and intensity [5].

Ergot sclerotia caused poisoning over whole regions, causing a variety of symptoms as Two types of ergotism which can be distinguished as “convulsive” and “gangrenous” ergotism. The first type is characterized by muscle spasms, fever and hallucinations. The victims may appear dazed, be unable to speak, become manic, or have other forms of paralysis or tremors, and suffer from hallucinations and other distorted perceptions. This is caused by serotonergic stimulation of the central nervous system by some of the alkaloids. Human fertility can be reduced during ergotism outbreaks because women frequently miscarry. The second type is accompanied by violent burning, peripheral pulses and shooting pain of the poorly vascularized distal organs, such as the fingers and toes, and is caused by the potent vasoconstriction effects of some ergot alkaloids [6].

Strategically imported wheat to Egypt which contaminated with quarantine pests such as sclerotium of ergot *(Claviceps purpurea)* which have a lot of variation from size dimension. Egypt later scrapped the restrictions and is now back to accepting shipments containing a maximum 0.05 percent ergot in imports, a quantity considered the standard limit by many countries. examine imported wheat it is very difficult imported Wheat have different impurities such as straw, grains from other crops, and insects, as well as undesirable substances thus cleaning and separating machine must have adjusted to remove all it. Accordingly, the main objective of this research is to monitoring the differences between the physical, chemical and optical properties of the wheat grain different varieties and Ergot fungi sclerotia. For the cereal sector, the presence of ergot creates a high toxicity risk for animals and humans because of its alkaloid content.

MATERIALS AND METHODS

Experiment was carried out through 2018 at the department of agriculture engineering

faculty of agriculture Egypt, to investigate physical, properties of the different varieties of the grain wheat imported to Egypt. These properties used in design and development of separating machine of the wheat grain and Ergot fungus. The grain and fungus dimensions tested under four different moisture content, and %.

Materials

Wheat crops *(triticun aestivum*). Russian Ukrainian and French wheat grain as showed in Photo 1 was used in this study, and Ergot fungi (*claviceps purpurea***)** sclerotia as showed in Photo 2.

For Image Analysis system it was used **ENVI programme.**

Wheat and Ergot sclerotia samples were captured by digital camera, using the capture card to transferred the data and stored on the PC. The ENVI software package was used to analysed the images of Wheat grains and Ergot sclerotia. There were three bands, RGB, (red, green, blue) were derived for each image until obtaining the R, G, B colours then colour indices. Photo 3 and 4 show ENVI software analysis.

Ergot fungi Scientific classification is shown in Table 1.

Table 1. Scientific classification of *Claviceps purpurea* fungi

Kingdom	**Fungi**
Division	Ascomycota
Class	Sordariomycetes
Subclass	Hypocreomycetidae
Order	Hypocreales
Family	Cclavicipitaceae
Sub-family	Faboideae
Genus	*Claviceps*

Source: en.m.wikipedia.org.

Photo 1. Wheat grains varieties
Source: Authors' determination.

Photo 2. Sclerotia of *clavicipes purpurea.*
Source: Authors' determination.

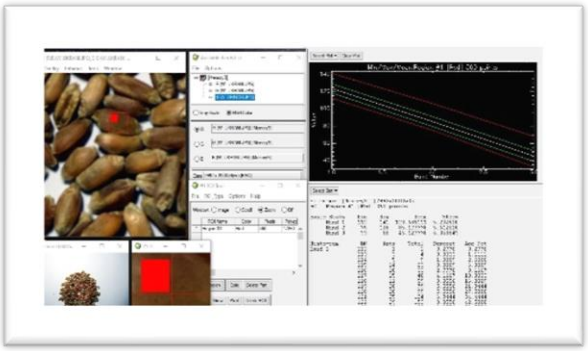

Photo 3. ENVI software analysis for Wheat
Source: Authors' determination.

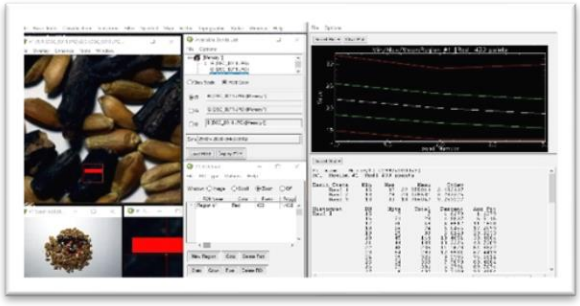

Photo 4. ENVI software analysis for Ergot
Source: Authors' determination.

Measurements and determinations.

- Physical properties.

-*Arithmetic mean diameter* (D_a), mm:

$$D_a = \frac{(x + y + z)}{3}$$

-*Geometric mean diameter* (D_g), mm:

$$D_g = (x.\ y.\ z)^{1/3}$$

-*Surface area* (A_s), mm^2:

$$A_s = \pi.,D_g^2$$

-*Volume* (V), mm^3:

$$V = \frac{\pi}{6}\ (x.\ y.z)$$

-*Sphericity* (φ), %

$$\varphi = \frac{(x.y.z)^{1/3}}{x} = \frac{D_g}{x}$$

where:

x: length of grains (mm),

y: width of grains (mm) and
z: thickness of grains (mm)

-*Density*: $\rho = m/v$ (gm./cm^3)

where:

m= Mass of sample, (gm).

v = Volume occupied by the sample, (cm^3).

-*Surface area*: $S_a = \Pi (D_g)^2$

Moisture content grains as determine as by dried in an oven of 103°C for 24h. All moisture percentages were determined on wet basis as it showed in equations below:

$M_w = (W_2 - W_1)/W_2 \times 100$

where:

M_w: Moisture content of soybean seeds sample on wet basis, (%),

W_1: Final mass of soybean seeds sample after drying, (g) and

W_2: Initial mass of soybean seeds sample before drying, (g).

Hue and saturation were calculated as these equations used to transform RGB color to HIS color determined I_2 and $I`_2$. Red/ Green ratio

$$H = COS^{-1}\left\{\frac{(2R-G-B)/2}{\left[(R-G)^2+(R-B)(G-B)\right]^{1/2}}\right\}$$

$$I = \frac{1}{3}(R+G+B)$$

$$I_2 = (R-B)/2$$

$$I'_2 = R-B$$

The three axial dimensions of seed are namely length “L, in mm” (longest intercept), width “W, in mm” (equatorial width perpendicular to L) and thickness “T, in mm” (breadth perpendicular to L and W). Measured by a digital Vernier-caliper with accuracy of 0.01 mm for randomly selected 100 seeds. Mean dimensions of wheat grain, the arithmetic mean diameter (D_a), mm, geometric mean diameter (D_g), mm, surface area (A_s), mm^2, volume (V), mm^3 and sphericity (φ), % of grains were also calculated.

RESULTS AND DISCUSSIONS

Physical properties of Ergot sclerotia (*claviceps pupepurea*)

The average length, width and thickness of Ergot sclerotia fluctuated from 2.23 to 22.51, 0.12 to 2.91 mm and 0.12 to 2.21 mm also volume ranged from 0.051 to 65.13 mm^3 as maximum and minimum value respectively. The arithmetic diameter, ranged from 1.07 to 9.1 mm, and geometric mean diameter increased from 0.46 to 4.98 mm. The surface area increased from 0.66 to 78.02 mm^2 and the sphericity increased from 7.93 to 55.6% with maximum and minimum value respectively (Table 2).

Table 2. physical properties of Ergot Sclerotia

Items	average	Min	Max
1,000 grains weight g	58.4	49.5	67.3
Length, mm	7.04	2.23	22.51
Width, mm	1.21	0.12	2.91
Thickness, mm	0.84	0.12	2.21
Volume, mm^3	6.33	0.051	65.13
Arithmetic diameter, mm	3.15	1.07	9.1
Geometric diameter, mm	1.25	0.46	4.98
Sphericity %	26.5	7.93	55.6
Flat surface area	7.82	.0523	51.42
Transfer surface area	1.03	0.013	4.94
Aspect ratio	17.8	2.06	47.2
Surface area, mm^2	13.7	0.66	78.02

Source: Authors' determination.

Physical properties of wheat grain

The average dimensions of ***Russian grain*** at constant moisture content 12.2 % were changed from min to max respectively, the length changed from 4.05 to 4.80 mm. width from 0.10, to 1.22 mm. thickness ranged from 0.10 to 1.15 mm. Volume 0.06 to 3.29 mm^3, geometric mean diameter from 0.48 to 1. 85 mm, the arithmetic mean diameter from 1.53 to 2.36 mm, and sphericity, changed to decrease from 38.4 to 10.50%. Also, surface area changed from 0.72 to 10.70 mm^2.

The average dimensions of ***Ukraine grain*** at constant moisture content 11.1 % were changed respectively, the length changed from 3.48 to 5.65 mm, width from 0.1 to 1.11 mm, thicknesses ranged from 0.10 to 0.71 mm, volume 0.07 to 1.73 mm^3, geometric mean diameter from 0.51 to 1. 49 mm, the arithmetic mean diameter from 1.32 to 2.28

mm, and sphericity changed to decrease from 31 to 14.50%. Also, surface area changed from 0.8 to 6.97 mm^2.

The average dimensions of ***French grain*** at a constant moisture content 13 % were changed respectively, the length changed from 3.38 to 6.31 mm, width from 1.67 to 2.77 mm, thickness ranged from 1.45 to 2.29 mm, volume 4.77 to 16 mm^3, geometric mean diameter from 2.09 to 3.12 mm, the arithmetic mean diameter from 2.23 to 3.47 mm, and sphericity, changed to decrease from 64.2 to 43.1%. Also, surface area changed from 13.7 to 30.6.mm^2 as showed in Table 3.

Table 3. Physical properties of wheat grain varieties

Wheat seeds	Russian	Ukraine	French
Length (mm)	5.24	5.24	5.17
width (mm)	1.92	1.92	2. 35
Thickness, mm	1.62	1.61	1.86
Volume, mm^3	8.81	8.75	12.1
Geometric mean diameter	2.52	2.52	2.82
Arithmetic mean diameter	2.92	2.92	3.13
Flat surface area	7.93	7.95	9.62
Transfer surface area	2.48	2.47	3.45
Aspect ratio	36.7	36.7	45.9
Sphericity	48.2	48.1	57.8
Surface area	20.3	20.2	25.2

Source: Authors' determination.

Physico- chemical properties of wheat grain

The physico-chemical properties are very important for detecting of wheat kernel parameters like uniformity of size, density and hardness, and also helps to determine the milling properties of different wheat varieties, the data presented in Table 4. The Russian wheat at moisture content 12.2% constant, the Hectoliter was 78.8 kg/m^3, thousand grains weight was 43.6 g, Falling number was 325, Glutens 24.8, index 97, and Immature grain 1.77%. The Ukrainian wheat at moisture content 11.1% constant, the Hectoliter was 78 kg/m^3, thousand grains weight was 42.1 g, Falling number was 351, Glutens 22.7, index 92.6, and Immature grain 1.8%. And the French wheat at moisture content 13% constant, the Hectoliter was 79.5 kg/m^3, thousand grains weight was 52.3 g, Falling number was 355, Glutens 20.7, index 95, and Immature grain 1.85%.

Table 4. Physico- chemical properties of wheat grain

Items	Russian	Ukrainian	French
Moisture content %	12.2	11.1	13
Hectoliter kg/m^3	78.8	78	79.5
1,000 grains weight g	43.6	42.1	52.3
Falling number	325	351	355
Glutens	24.8	22.7	20.7
Index	97	92.6	95
Immature grain %	1.77	1.8	1.85

Source: Authors' determination.

Optical properties of wheat varieties origin and its sclerotia

The data from Table 5 are resulted using ENVI programme analysis and investigated the colour analysis of the different varieties of wheat and sclerotia origin. Red band(R), Green band(G), Blue band(B), Intensity(I), Hue (H), and Red/Green band (R/G).

Table 5. Optical properties of wheat varieties origin and its sclerotia

Indices	W. R	W. Uk	W. F	E. R	E. Uk	E. F
R	117.8	123.3	82.6	30.8	28.9	22.9
G	89.2	89.7	58.2	26	23.7	20.1
B	46.5	50	26.5	25.2	20.8	19.1
H	0.64	0.57	0.59	0.5	0.47	0.78
I	84.5	87.7	55.8	27.3	24.5	20.7
I2	35.6	36.6	28	2.76	4	1.9
I3	3.5	1.5	1.8	-1	-0.5	-0.4
I-2	71.3	73.3	56	5.5	8	3.8
I-3	7	3.1	3.6	-2	-1.1	-0.8
R/G	1.3	1.39	1.5	1.17	1.2	1.14

Source: Authors' determination.

The results showed that the Ukrainian wheat recorded the highest value of RGB band 123.3, 89.7, 50 and Intensity 87.7.

But the highest Hue value 0.64 observed in the Russian wheat, while the French wheat recorded the lowest value of RGB band 82.6, 58.2, 26.5 and Intensity 55.8. On the other hand, Russian ergot sclerotia recorded the highest value of RGB band 30.8, 26, 25.2 and Intensity 27.3.

While the French ergot sclerotia recorded the lowest value of RGB band 22.9, 20.1, 19.1 and Intensity 20.7. and the highest Hue value 0.78.

Color indices for Wheat varieties origin and Ergot sclerotia

The figures study the relationship between color indices and different varieties of wheat & Ergot sclerotia. The results show high variances in color indices for different wheat varieties and ergot sclerotia origin in Figs. 1, 2, and 3.

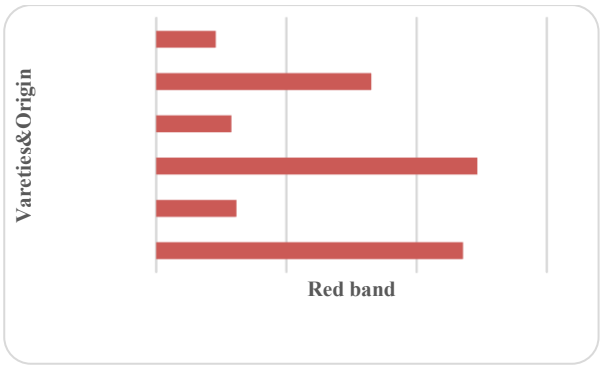

Fig. 1. Relationship between Red band and different varieties of wheat and Ergot sclerotia
Source: Authors' determination.

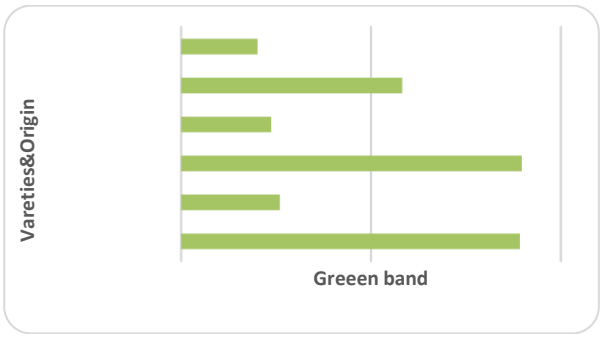

Fig. 2. Relationship between Green band and different varieties of wheat and Ergot sclerotia
Source: Authors' determination.

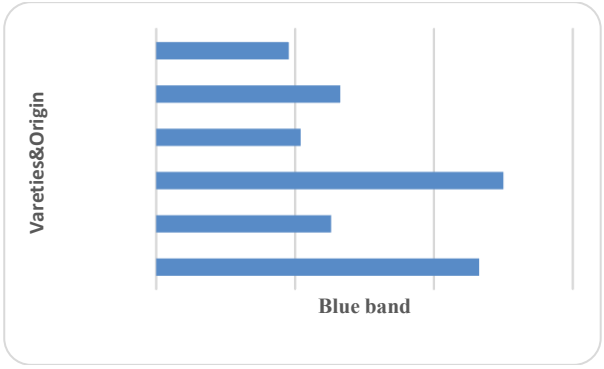

Fig. 3. Relationship between Blue band and different varieties of wheat and Ergot sclerotia
Source: Author determination.

The highest value of RGB band 123.3, 89.7, 50 were observed in the Ukrainian wheat. On the other hand, Russian ergot sclerotia recorded the highest value of RGB band 30.8, 26, and 25.

Fig. 4 illustrates the relationship between intensity and different varieties of wheat & Ergot sclerotia. The Ukrainian origin was the highest variances between wheat and sclerotia where 87.7 and 24.5 intensity, the French origin recorded the lowest value of Intensity for Wheat 55.8 ergot sclerotia 20.7 .

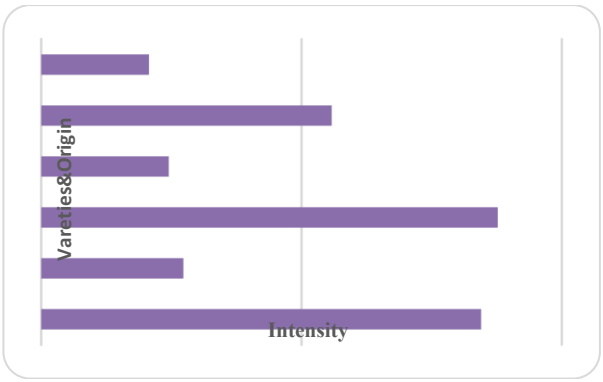

Fig. 4. Relationship between Intensity band and different varieties of wheat and Ergot sclerotia
Source: Authors' determination.

Fig. 5 explicates the relationship between Hue band and different varieties of wheat and Ergot sclerotia whereas, the ergot French was the highest 0.78 value and the Ukrainian was the lowest 0.47 value. There weren't clear Hue variances between different origin.

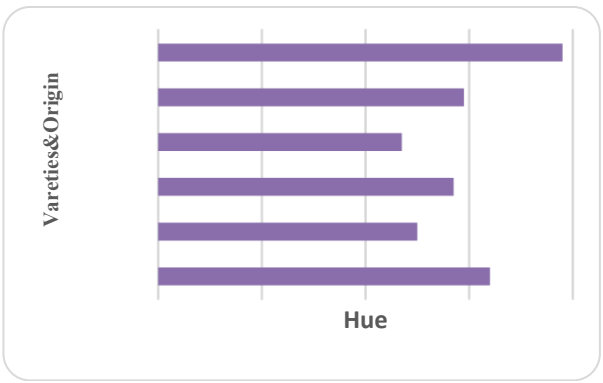

Fig. 6. Relationship between Hue band and different varieties of wheat and Ergot sclerotia
Source: Authors' determination.

Fig. 7 shows the relationship between Red/Green band and different varieties of wheat and Ergot sclerotia. The French wheat was 1.5 value followed by the Ukrainian

wheat 1.39 but the Russian wheat was 1.3, on the other hand the variances between different origin for ergot are close where 1.17, 1.2, and 1.14 for Russian, Ukrainian and French Ergot respectively.

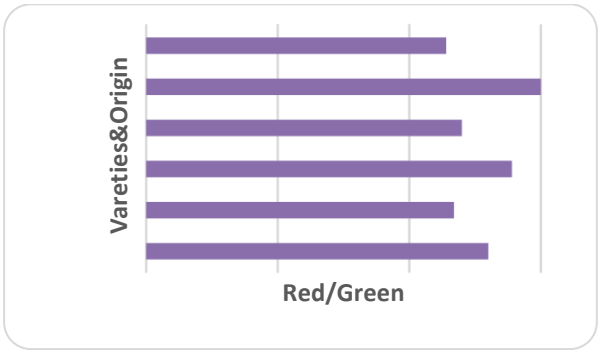

Fig. 7. Relationship between Red/Green band and different varieties of wheat and Ergot sclerotia
Source: Authors' determination.

CONCLUSIONS

Color can distinguish between different varieties of wheat imported from different countries. It is also possible to distinguish between Ergot fungi sclerotia and between different types of imported wheat, and the color indicators used showed a clear contrast between wheat and Ergot fungi sclerotia, for example. The physical specifications also showed the differences that distinguish between mushrooms and wheat, which can be used to design the sieve holes for the specific separation.

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