Libyan Agriculture Research Center Journal International 2 (5): 221-223, 2011
ISSN 2219-4304

Classification of Egg Size and Shape Based on Mass and Outer Dimensions Analysis

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Abstract: Egg size and shape are the most important quality parameters for evaluation by customer performance. In addition, misshapen eggs are generally rejected according to sorting standards. This study was conducted to determine quantitative classification algorithm for egg size and shape. To reach objective and reproducible results, mass and outer dimensions (length and diameter) of egg were measured and an assessment based on mass and outer dimensions analysis was proposed. Results of the study indicated that mass and aspect ratio (length to diameter ratio) of egg can be used effectively to determine normal and misshapen egg.

Key words: Egg % Size % Shape % Sorting % Mass % Outer dimensions

INTRODUCTION

Egg is considered as one of the basic foodstuffs due to its very high nutritive value. Besides a rich source of protein, it contains a fair amount of nutrients (Sodium, Potassium, Calcium, Phosphorus, Magnesium, Iron, Zinc, Copper, Iodine, Sulfur and Selenium) and vitamins (A, B_1, B_2, B_3, B_6, B_{12}, D and E). Egg contains 87-90% edible portion, 65-70% moisture, 11.0-12.5% protein and 9.5-10.8% oil [1, 2].

Egg size and shape are the most important quality parameters for evaluation by consumer preference. Consumers prefer eggs of equal size and shape [3, 4]. Sorting can increase uniformity in size and shape, reduce packaging and transportation costs and also may provide an optimum packaging configuration [5-7]. Moreover, sorting is important in meeting quality standards, increasing market value and marketing operations [8]. Sorting manually is associated with high labor costs in addition to subjectivity, tediousness and inconsistency which lower the quality of sorting [9]. However, replacing human with a machine may still be questionable where the labor cost is comparable with the sorting equipment [10]. Studies on sorting in recent years have focused on automated sorting strategies and eliminating human efforts to provide more efficient and accurate sorting systems which improve the classification success or speed up the classification process [11, 12].

On the other hand, the official quality definitions for sorting food and agricultural materials are hardly more than a measure on size and shape. Most sorting standards specify size and shape based on visual comparison of size and shape relative to reference drawings. These drawings serve as references in classifying size and shape. Although ratings based on visual comparison do not require any equipment, the method is subjective and may depend on person executing the rating. Moreover, rating scores may be biased by confusing variables such as size or shape [5-7]. Substitute approaches describe size and shape using indices calculated from physical and geometrical properties of food and agricultural materials [5, 13, 14]. Since such approaches are based on direct measurement, they are objective and reproducible. In addition, necessary measurements can be performed easily and no complicated equipment is needed. Accordingly, the present study was conducted to develop a fast procedure that permits an un-biased and reproducible quantitative description of egg size and shape based on mass and outer dimensions analysis.

MATERIALS AND METHODS

Experimental Procedure: One hundred randomly selected eggs of various sizes and shapes were purchased from a local market. Eggs were selected for freedom from defects by careful visual inspection, transferred to the laboratory and held at 5±1°C and 90±5% relative humidity until experimental procedure. In order to obtain required parameters for egg size and shape detection algorithm, the mass of each egg was measured to 0.1 g accuracy on a digital balance. In addition, the outer dimensions of each egg, i.e. length and diameter (Fig. 1) were measured to 0.1

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Table 1: The mean values, standard deviation (S.D.) and coefficient of variation (C.V.) of some physical and geometrical properties of the 100 randomly selected eggs

Parameter	Minimum	Maximum	Mean	S.D.	C.V. (%)
Mass, g	42.1	58.3	50.9	2.8	5.5
Length, mm	42.8	58.9	53.9	2.2	4.0
Diameter, mm	38.5	52.3	41.1	1.4	3.5
Aspect ratio	1.03	1.47	1.31	0.1	4.8

Table 2: Size, shape, mass range, aspect ratio range, description and number of normal and misshapen eggs

Size	Shape	Mass range (g)	Aspect ratio range	Description	Number (%)
Small	Spheroid	< 46	< 1.2	Misshapen	0
	Ellipsoid	< 46	1.2 - 1.4	Misshapen	4
	Spindly	< 46	> 1.4	Misshapen	0
Medium	Spheroid	46 - 54	< 1.2	Misshapen	1
	Ellipsoid	46 - 54	1.2 - 1.4	Normal	79
	Spindly	46 - 54	> 1.4	Misshapen	5
Large	Spheroid	> 54	< 1.2	Misshapen	1
	Ellipsoid	> 54	1.2 - 1.4	Misshapen	9
	Spindly	> 54	> 1.4	Misshapen	1

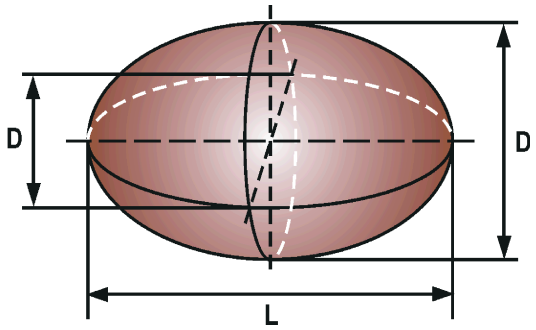

Fig. 1: The outer dimensions of an egg; length (L) and diameter (D)

mm accuracy by a digital caliper. Table 1 shows some physical and geometrical properties of the 100 randomly selected eggs.

Egg Size Detection: Primary investigation based on the results of study indicated that three egg sizes, i.e. small, medium and large were detectable and separable in the samples.

Egg Shape Detection: An easy technique of judging based on analysis of outer dimensions of egg was used for detecting shape of egg. Aspect ratio was used to detect spheroid, ellipsoid and spindly eggs. Aspect ratio is defined by equation 1 [5-7, 15].

$$A.R. = L / D , (A.R. \$ 1.0) \quad (1)$$

Where:

A.R. = aspect ratio, dimensionless
L = length of egg, mm
D = diameter of egg, mm

For mathematical describing of normal and misshapen egg, mass of eggs and aspect ratio values were subjected to statistical analysis using the Microsoft Office Excel (Version 7.0 - 2003).

RESULTS

Small, Medium and Large Egg Sizes: Mass of medium size eggs ranged from 46 g to 54 g, while mass of small size eggs were less than 46 g and mass of large size eggs were more than 54 g. Therefore, the mass lines 46 g and 54 g can separate medium size eggs from small size and large size eggs as shown in Fig. 2.

Spheroid, Ellipsoid and Spindly Egg Shapes: Aspect ratio of ellipsoid shape eggs ranged from 1.2 to 1.4, while aspect ratio of spheroid shape eggs were less than 1.2 and aspect ratio of spindly shape eggs were more than 1.4. As a result, the aspect ratio lines 1.2 and 1.4 can separate ellipsoid shape eggs from spheroid shape and spindly shape eggs as indicated in Fig. 2.

Normal and Misshapen Eggs: Among nine size and shape combinations (three sizes × three shapes); samples with "medium size × ellipsoid shape" combination were considered as normal eggs. Eggs with other size and shape combinations were considered as misshapen eggs. Fig. 2 shows the mass lines 45 g and 55 g in association with the aspect ratio lines 1.2 and 1.4 can separate normal eggs from misshapen eggs.

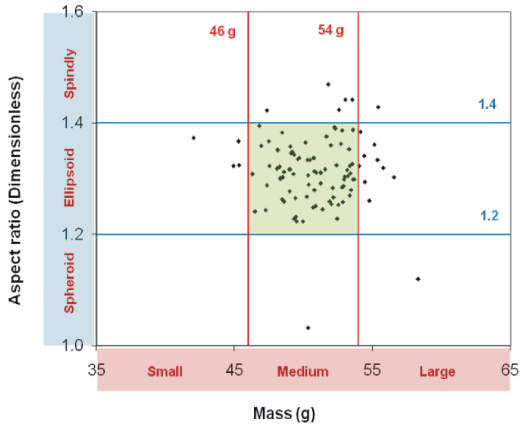

Fig. 2: Aspect ratio versus mass and separator lines of normal eggs from misshapen eggs

DISCUSSION

In this study, mass and outer dimensions (length and diameter) of egg were analyzed to classify egg size and shape. Results of study indicated that three sizes (small, medium and large), three shapes (spheroid, ellipsoid and spindly) and consequently nine size and shape combinations (three sizes × three shapes) were detectable and separable in the eggs. Results of study also showed that among three sizes, number of medium size eggs was the highest (85%), while number of small size eggs was the lowest (4%). Number of large size eggs was 11%. Besides, among three shapes, number of ellipsoid shape eggs was the highest (92%), while number of spheroid shape eggs was the lowest (2%). Number of spindly shape eggs was 6%. Moreover, amount of normal eggs and all kinds of misshapen eggs were 79% and 21%, respectively. These results are in line with those of Sadrnia *et al.* [5], Rashidi and Seyfi [6] and Rashidi and Gholami [7] who concluded that some geometrical properties of fruit can be used effectively to determine normal and misshapen fruit. These results are also in agreement with those of Ku *et al.* [13] and White *et al.* [14] who reported that classification of fruit using indices calculated from outer dimensions of fruit can increase uniformity in size and shape.

CONCLUSION

It can be concluded that mass and aspect ratio of egg can be used effectively to determine normal and misshapen egg.

ACKNOWLEDGMENT

The author is very much grateful to “Shahre-rey Branch, Islamic Azad University, Tehran, Iran” for giving all type of support in publishing this study.

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