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Understanding Stability of Biological Materials from Engineering Prospective

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Editorial

Different techniques are presented that measure non-destructively eggshell. The incidence of broken and cracked eggs range from 6-8% of all eggs produced. Breaking force strength has proven to be closely related to the proportion of broken eggs but the relationship with non-destructive measurements is not yet clear. Therefore, the relationship of deformation (static stiffness), compression cone hardness and dynamic stiffness with breaking force strength was measured as a non-destructive alternative. Researchers explained that, Samples of white and brown eggs from hens at different ages were used for deformation analysis, acoustic impulse (using an acoustic crack detection device), compression cone hardness and breaking force strength. Calculations from multiple regressions indicated that compression cone hardness and dynamic stiffness have stronger influences on breaking force strength than static stiffness (deformation). It seems to be necessary, to develop other measurements for estimating eggshell quality without destroying the egg shell. Compression cone hardness (CCH), shell deformation, shell breakage strength, shell thickness, static stiffness, dynamic stiffness and shell mass had the best coefficients of correlation. Also it was the best assessment for practical large scale uses, because the age changes the characteristics of egg shell quality from time to time. Intact eggs produced sound signals mainly exhibiting a single dominant peak in the frequency range of 3000- 8000 Hz with signal duration of about 20ms. The cracked eggs showed frequency spectra in relatively wider frequency range of 2000-10000 Hz and shorter signal duration of about 15ms. Finally, it was concluded that the influence of the material strength (breakage force) upon total eggshell strength (crack detector) is limited. Calculations from multiple regressions indicated that compression cone firmness and dynamic stiffness have stronger influences on static stiffness than breakage force strength. Structural strength, (CCH) on the other hand plays a more important role upon total shell strength for eggshell stability and relating the structure to its functional properties and textures behind the strength of biomaterials could be used in the attempt of bioengineering new systems, where it would offer an excellent method to understand eggshell solidity to improve eggshell quality and reduce the incidence of cracked eggs.

Both environmental and genetic factors affect the strength or quality of any eggshell, and hence its likelihood of cracking during normal egg handling processes. To some extent the environmental factors can be controlled, for example, through improvements in bird management and nutrition. Nevertheless genetics remains an important way to reduce eggshell breakage, as it is both permanent and cumulative. For decades, breeding companies have used laboratory-based measurements such as shell breaking strength, nondestructive deformation and specific gravity in their selection programmers. While these measurements have generally responded to selection, it has been notoriously difficult to prove that they directly relate to the incidence of breakage in the field.

Eggshell strength is generally measured using either direct tests, such as nondestructive deformation or destructive fracture force of an egg under quasi static compression between 2 parallel plates, or indirect tests, such as the measurement of eggshell thickness. Many of these methods, however, are destructive, slow, or subject to environmental influences and, hence, are regarded as being unpractical. Researchers presented a fast, objective, and nondestructive method for the determination of the eggshell strength, based on acoustic resonance analysis. This technique measured the resonant frequency (RF) of the egg and its damping ratio. Based on the (RF) and the egg weight, the dynamic shell stiffness (Kdyn) was defined. This technique can also be used to detect cracks in the eggshell. Several authors have since shown that the Kdyn is a useful eggshell quality measurement. Among others, Researchers investigated the relationship between some measures of shell quality (specific gravity, breaking strength, shell thickness, percentage of shell and shell weight per unit of surface area) and egg breakage in practice. The mechanics and mechanisms of failure of hens' eggs have been examined through punch tests demonstrate the importance of establishing damage over a critical area before macroscopic failure of the eggshell occurs at the maximum load when one or more of the micro-cracks become unstable.

Structural strength, on the other hand, is related to the interaction among the building units and depends on several variables, namely size, shape, thickness, and distribution of the shell components. Most technique that aim at quantifying eggshell strength measure eggs as a whole and thereby make no distinction between these 2 properties.

Industrial relevance: The examination of cracks on eggshell was usually conducted by floodlighting before, but it gives eye fatigue, makes misjudgment and is not easy to detect hairline crack. The acoustic impulse response method was suggested in this research to measure hairline crack for eggshell using flexible piezoelectric film sensors. The result was found that the acoustic impulse response method can distinguish between intact egg and cracked egg. This research provides a technology detection of cracked egg. Recent researches on the detection of eggshell crack are mainly focused on the vibration-based response analysis. For instance, analyzed the frequency pattern of acoustic signal by impact on the places around the equator and detected the cracks on eggshell. The crack detection level of 90% was possible by using the Pearson correlation coefficient as an evaluation factor from the impacts on four different locations around the egg equator. Researchers developed an inspection system to detect eggshell crack in an eggshell using acoustic impulse response method.

Applications of soft computing in agricultural and biological engineering with the theoretical developments of soft computing, a large variety of successful applications to many industrial systems have been created. During the last decade, interest of applying soft computing techniques to systems in agricultural and biological engineering has been growing greatly. As in other fields, soft computing plays an especially important role in providing techniques to integrate human-like vagueness and real-life uncertainty into conventional computing programs. Problems in soil and water, crop management and post harvesting, precision agriculture, food processing, food quality and safety, and agricultural vehicle and robotics have been solved through soft computing-based classification, modeling and prediction, and optimization and control.

Soft computing is a set of computing techniques, such as Fuzzy Logic (FL), Artificial Neural Networks (ANNs), and Genetic Algorithms (GAs). These computing techniques, unlike hard computing, which refers to a huge set of conventional techniques such as stochastic and statistical methods, offer somewhat “inexact” solutions of very complex problems through modeling and analysis with a tolerance of imprecision, uncertainty, partial truth, and approximation. In effect, soft computing is an integration of biological structures and computing techniques. FL develops multi-valued, non-numeric linguistic variables for modeling human reasoning in an imprecise environment. ANNs provides configurations made up of interconnecting artificial neurons that mimic the properties of biological neurons. GAs is a way of solving problems by mimicking the same processes nature uses through selection, recombination and mutation.

This article is an attempt to review is to investigate the effect of handling and storage environmental conditions on the nondestructive measurements as a physical property of biological materials and their components and production losses. Also, a comprehensive review for research work carried out on many biological materials processing, handling and quality is followed as a bioengineering material.