Alnakhla
Journal of Science (AJOS)
www.alnakhlajos.com
Print ISSN: 3007 – 0198
Online ISSN: 3007 – 0201

Effect of microwave pasteurization on quality characteristics of table eggs during refrigerator storage

Ther H. Ismail, Tiba T. Atiyah and Shahrazad M.J. Al-Shadeedi*
College of Veterinary Medicine, University of Baghdad, Iraq.

***Correspondence:**
shahrazad@mracpc.uobaghdad.edu.iq
Received: February 12th 2024
Accepted: April 24th 2024
Published: May 15th 2024

ABSTRACT

An experiments were carried out at the College of Veterinary Medicine, University of Baghdad, during the period from October 26th 2023 to December 20th 2023, to study the effect of pasteurizing treatments of shell table egg using traditional Microwave oven on its quality characteristics during Zero, 1, 2, 4 and 8 weeks of refrigerator storage. A total of 120 fresh table eggs (White shell eggs) were collected from 20000 Luhman layer hens flock at Al-Amir project commercial farm, Al-Musaib city. These eggs were divided into 4 treatment of microwave pasteurization treatments which were Zero, 10, 20, and 30 sec. Results revealed that significant differences ($P<0.05$) for the internal characteristics of the egg after storage for 2, 4 and 8 weeks in the refrigerator, where the control treatment recorded the lowest value. The effect of microwave pasteurization treatments on the internal components of the egg after storage in the refrigerator for 4 and 8 weeks. In conclusion, microwave pasteurization of table egg is very imported to extending shelf life of table eggs during refrigerator storage.

Keywords: Table eggs, Pasteurization, Microwave, Quality characteristics, Storage.

Introduction

Eggs are considered highly perishable food, just like milk and meat. Therefore, they require storage and preservation conditions to protect them from deterioration and spoilage, especially microbial spoilage. Contamination of eggs with microorganisms begins as soon as they leave the hen's body (oviposition), and microorganisms quickly begin to increase on the surface of the egg shell as the storage period increases, especially in cases of high temperatures and high humidity, in addition to the deterioration of the internal qualitative characteristics of the egg as a result of the release of CO_2 gas from the inside of the egg (Al-Obaidi and Al-Shadeedi, 2022). Fresh eggs contain three layers of protection, which are the outer cuticle layer, or called the outer waxy layer, then the calcareous shell, and then comes the inside membrane of the shell, which is an outer and inner membrane. Each of these layers has an important and effective role in protecting the egg and limiting or hindering the entry of microorganisms (Morsy et al., 2015; Al-Shadeedi, 2023; Salman et al., 2023).

There is no ideal method for storing eggs that prevents them from being damaged or spoiled, but eggs are stored to reduce the deterioration in their quality and prolong their storage period. Eggs are transported from production fields to refrigerated wholesale warehouses before they reach the consumer using cardboard trays with a capacity of 30 eggs, placed inside cardboard boxes of one capacity. A total of 12 layers of cardboard and in this form it is marketed to single-stores. Eggs prepared for storage must be clean and free of external defects, as these eggs are more resistant to microbial contamination and storage conditions (Dev, et al., 2008; Shenga et al., 2010; Al-Shadeedi, 2018; Oliviera et al., 2022). Numerous studies have

been conducted over a long period of time to determine the ideal conditions for storing eggs in order to preserve their internal quality and increase their shelf life for consumption (Sliversides and Scott, 2001; Al-Shadeedi, 2009; Al-Shadeedi, 2010).

Modern trends in the processes of preserving and storing table eggs depend on thermal treatment, either using very high heat and a short time (high temperature short time) or moderate heat and a relatively long time (low temperature long time) with refrigeration in refrigerator conditions (Scott and Silversides, 2000; USDA, 2007), Wilburn (2006) recommended the need to pasteurize table eggs with their shells at a temperature of 57°C for 20 minutes to eliminate pathogenic germs that may be present on the surface of their shells or in the internal contents of the eggs. Al-Shadeedi (2009) found that the thermal stabilization treatment of table eggs with medicinal oils, which included dill oil and black seed oil, was better than treating them with corn oil in reducing the deterioration in the qualitative and microbial characteristics of the eggs and prolonging their suitability for storage under room conditions and also in refrigerator conditions. Al-Obaidi (2010a) and Al-Obaidi et al., (2010b) found, for the first time locally, treating fresh table eggs with water vapor for short periods of 5, 10, and 15 seconds as a means of reducing deterioration in their qualitative, chemical, and functional characteristics when stored in refrigerator conditions.

Pasteurization of eggs in the shell using a low temperature of 55°C and a long time of 180 minutes extends the shelf life of eggs in the refrigerator for up to seven weeks without showing a decrease or deterioration in their qualitative and chemical characteristics (Hank et al., 2010). Al-Obaidi (2010a) and Al-Obaidi et al. (2010b) found that pasteurizing fresh table eggs with water vapor for 5, 10 and 15 seconds led to no significant deterioration in the quality and chemical characteristics of eggs after storing them in the refrigerator for two weeks. Also, treating fresh table eggs with dry heat or in a microwave oven and storing them led to no significant deterioration in their qualitative characteristics, in addition to a decrease in the number of microorganisms on the surface of their shells immediately after treatment and after storage compared to untreated eggs (Sivaramakrishnan, 2010).

The aim of the current research is to study the effect of treating fresh table eggs for different periods of time in a microwave oven (0, 10, 20 and 30 sec.) as a means of pasteurization and its effect on their internal quality characteristics after storing in the refrigerator for (0, 1, 2, 4, and 8) weeks.

Materials and Methods

Period of the study: An experiments were carried out at the College of Veterinary Medicine, University of Baghdad, during the period from October 26th 2023 to December 20th 2023, to compare between three period of pasteurizing treatments of shell table egg which were 10, 20, and 30 second using traditional Microwave oven on its quality characteristics, egg components percentage and microbial counts during Zero, 1, 2, 4 and 8 weeks of refrigerator storage.

Egg collection: A total of 120 fresh table eggs (White shell eggs) were collected from 20000 Luhman layer hens flock at Al-Amir project commercial farm, Al-Musaib city, the layers were fed a production ration as explain in Table (1).

Table (1): Components and ingredients quantity of ration.

Components	Ingredients quantity in 2 tons
Corn	650
Soya Meal	500
Wheat	200
Wheat bran	100
Rice bit	200
Chickpea	100
Premix	50
Vegetable oil	25
Limestone	125
Total	2000 Kg

Treatments: the experiment was to compare between three period of pasteurizing treatments of shell table egg which were microwave exposed for 10, 20, and 30 second using traditional Microwave

oven on its quality characteristics, egg components percentage and microbial counts during Zero, 1, 2, 4 and 8 weeks of refrigerator storage. After egg collection 120 eggs were immediately distributed into four groups of treatments :

T1: 30 eggs were untreated eggs as control group.
T2: 30 eggs were microwave exposed for 10 sec.
T3: 30 eggs were microwave exposed for 20 sec.
T4: 30 eggs were microwave exposed for 30 sec.
All eggs were refrigerator storage immediately after treatment.

Storage periods: All washed eggs were refrigerator storage for 1, 2, 4 and 8 weeks. Al each period 5 eggs from each treatment were randomly collected and individually weight and interior quality parameter were studied.

Microwave oven: A commercial microwave oven was used, one of the types of ovens used for home purposes, type (SAMSUNG), Chinese origin.

Quality parameters:

Egg weight: Egg weights were recorded for each egg separately and for each treatment, and after each storage period, a digital Sartorius balance scale was used for this purpose, measuring to two orders of grams before and after the start of packaging.

Internal egg quality characteristics: All studied egg quality (internal) traits were measured for all collected eggs individually and according to the method indicated by Stadelman and Cotterill (1995) which included egg weight, white high, yolk high and yolk diameter.

White Height, Yolk Height and Yolk Diameter: The white and yolk height was measured by using vertical digital micrometer for the white of each egg, from the midpoint between the edge of the outer white and the yolk membrane, the high of the yolk measured in the midpoint of the yolk. The diameter of the yolk were measured by using the digital Vernier scale.

Statistical analyses: Data were analyzed by using the General Linear Model Procedure of SAS (2001). Means were compared by the Duncan's Multiple Range test at 5% probability (Steel and Torrie, 1980).

Results and Discussion

Egg weight: It is clear from Figure (1) that the weight of table eggs immediately after pasteurization in the microwave (Zero time) ranged between (55.3 and 55.56 gm), and that there was a noticeable increase in the control treatment, and as the period of storage in the refrigerator progressed to one, two, and four weeks. Eight weeks later, the control treatment recorded a significant decrease in egg weight compared to the microwave pasteurization treatments, where its value reached (54.72, 53.56, 51.85, 46.57) gm after storage for the aforementioned periods, respectively. The microwave pasteurization treatment for (10 sec.) recorded the egg weight and its amount (55.21, 54.61, 52.9, 50.44) gm after storage for 1, 2, 4, and 8 weeks respectively. The microwave pasteurization treatment was recorded for a period of 10 seconds. (20 sec.) Egg weight and amount (54.93, 53.13, 50.81) gm after storage for 2, 4, and 8 weeks respectively. Likewise, the microwave pasteurization process for (30 sec.) recorded an egg weight of (53.15, 51.19) gm after storage for periods of 4 and 8 weeks respectively.

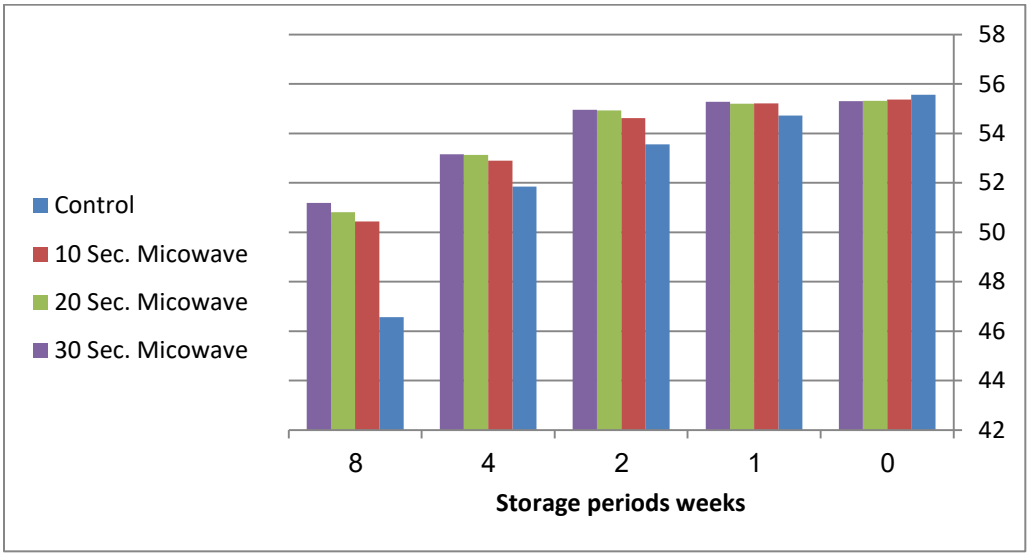

Figure (1): Effect of microwave treatments on table egg weight during refrigerator storage

Interior quality: Table (2) shows the effect of the duration of microwave pasteurization on some internal qualitative characteristics of the egg immediately after the treatment, as it is clear that the height of the yolk ranges between (16.18 - 16.22) for the four treatments and without a significant difference. Likewise, no significant differences appeared in all of them. Among the characteristics of the diameter of the yolk, the index of the yolk, and the height of the white, their values ranged between (36.59 - 36 710), (0.44), (8.53- 8.58) for the three treatments respectively.

Table (2): Effect of microwave treatments on interior table egg quality at Zero time of refrigerator storage.

Microwave Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	16.22 ±0.33a	36.66 ±0.81a	0.44 ±0.04a	8.54 ±0.69a
10 Sec.	16.18 ±0.32a	36.59 ±0.79a	0.44 ±0.03a	8.58 ±0.72a
20 Sec.	16.19 ±0.32a	36.71 ±0.83a	0.44 ±0.03a	8.56 ±0.68a
30 Sec.	16.20 ±0.34a	36.68 ±0.81a	0.44 ±0.05a	8.53 ±0.69a
Significant	N.S.	N.S.	N.S.	N.S.

As the storage period progressed to one week in the refrigerator, the situation did not change significantly and it did not ripen. There were significant differences (P<0.05) in the characteristics of the height of the yolk and the diameter of the yolk. 44), (8.10-8.39) for the four treatments respectively (Table 3).

Table (4) shows the appearance of significant differences (P<0.05) for the internal characteristics of the egg after storage for two weeks in the refrigerator, where the control treatment recorded the lowest value for the height of the yolk, reached (15.13), and the highest value for the diameter of the yolk, reached (36.02). The index of the yolk was (0.42) and the height of the white was (7.73). Table (3) indicates the effect of the duration of microwave pasteurization on the internal quality characteristics of table eggs after storage for two weeks in the refrigerator. Table (5) indicates the appearance of significant differences (P<0.05) for the internal characteristics of the egg after storage for four weeks in the refrigerator, where the control treatment recorded the lowest value for the height of the yolk, reaching (14.38), and the highest value for the diameter of the yolk, reaching (37.75). Likewise, the lowest value for the yellow index reached (0.38), the highest value reached (0.41), the lowest value for the whiteness index reached (6.51), and the highest value reached (7.54). Table (6) indicates the effect of the duration of microwave pasteurization on the internal quality characteristics of table eggs after storage for four weeks in the refrigerator. It is also evident in Table (6) that there are significant differences (P<0.05) for the internal qualitative characteristics of the egg after storage for eight weeks in the refrigerator, where the control treatment recorded the lowest value for yolk height, reaching (11.46), and the highest value, reaching (13.95). the lowest value for the diameter of the yolk (39.02) and the highest value for it was (41.53), as well as the index of the yolk, the lowest value for it (0.25) and the highest value for it was (0.36) and the lowest value for the height of the white, as it reached (4.67). Its highest value was (6.90).

The results obtained from this research with regard to the egg weight characteristic shown in Table (2) indicated the appearance of significant differences after storage for a period of (2, 4, 8 weeks). This indicates that the microwave pasteurization treatments contributed significantly to preserving the loss of character in the weight of the egg as it progressed in storage. This is consistent with studies that indicated that increasing the duration of storage of eggs leads to the loss of moisture and CO_2 gas from inside the egg to outside the egg and this is due to the presence of open pores in the egg shell, which are naturally present (Silversides and Scott, 2001; Stadelman and Cotterill, 1995).

Table (3): Effect of microwave treatments on interior table egg quality after 1 week of refrigerator storage.

Microwave Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	15.97 ±0.31a	36.83 ±0.80a	0.44 ±0.02a	8.10 ±0.67a
10 Sec.	16.02 ±0.29a	36.77 ±0.78a	0.44 ±0.03a	8.31 ±0.68a
20 Sec.	16.04 ±0.30a	36.77 ±0.81a	0.44 ±0.02a	8.39 ±0.66a
30 Sec.	16.07 ±0.31a	36.76 ±0.80a	0.44 ±0.02a	8.38 ±0.67a
Significant	N.S.	N.S.	N.S.	N.S.

Table (4): Effect of microwave treatments on interior table egg quality after 2 weeks of refrigerator storage.

Microwave Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	15.13 ±0.32b	36.02 ±0.77a	0.42 ±0.02b	7.73 ±0.65b
10 Sec.	15.59 ±0.31a	36.36 ±0.79b	0.43 ±0.02a	8.00 ±0.67a
20 Sec.	15.76 ±0.32a	36.37 ±0.76b	0.43 ±0.02a	8.15 ±0.68a
30 Sec.	15.70 ±0.32a	36.41 ±0.77b	0.43 ±0.02a	8.18 ±0.66a
Significant	*	*	*	*

Table (5): Effect of microwave treatments on interior table egg quality after 4 weeks of refrigerator storage.

Microwave Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	14.38 ±0.33c	37.75 ±0.74a	0.38 ±0.01c	6.51 ±0.61b
10 Sec.	15.03 ±0.30b	37.31 ±0.71b	0.40 ±0.02a	7.11 ±0.67a
20 Sec.	15.40 ±0.30a	37.19 ±0.75b	0.41 ±0.01a	7.42 ±0.63a
30 Sec.	15.44 ±0.31a	37.15 ±0.73b	0.41 ±0.01a	7.54 ±0.62a
Significant	*	*	*	*

The decrease in the loss of water and CO_2 gas in eggs in pasteurization procedures is an inevitable result of the effect of heat, which denaturation a small portion of the thin layer of the light outer white, which acts as a barrier that prevents the exit of water and CO_2 gas from inside or outside the egg, since the egg white is a colloidal solution. Watery with a high concentration of water and therefore easy for water to exit from it (North, 1984; Stadelman and Cotterill, 1995; Scott and Silversides, 2000).

It can be noted from these results in Table (2) that the least loss in egg weight occurred with increasing the duration of pasteurization in the microwave, and this is the result of increasing the duration. Exposure to microwaves leads to the appearance or formation of a thicker layer of denaturation protein (Stadelman and Cotterill, 1995). The greatest evidence of this is that the weight and percentage of the peel increased in the microwave pasteurization treatments compared to the control treatment, as indicated by Table (8) after Zero time treatment.

Table (6): Effect of microwave treatments on interior table egg quality after 8 weeks of refrigerator storage.

Microwave Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	11.46 ±0.27c	41.53 ±0.65a	0.28 ±0.01c	4.67 ±0.62c
10 Sec.	12.89 ±0.28b	39.74 ±0.69b	0.32 ±0.02b	5.86 ±0.60b
20 Sec.	13.77 ±0.30a	39.20 ±0.75c	0.35 ±0.01a	6.61 ±0.65a
30 Sec.	13.95 ±0.31a	39.02 ±0.73c	0.36 ±0.01a	6.90 ±0.64a
Significant	*	*	*	*

Regarding the results of the internal characteristics of eggs, and as expected immediately after treatment, there were no significant differences, and this was clear, and the differences began to appear after storage for two weeks, as shown in Table (5) between the treatments for the moral characteristics (yolk height, yolk diameter, Yolk index, white height) for cold storage (refrigerator) An important role in reducing the deterioration of the quality characteristics of the egg. The results of this study are consistent with the results of research (Sabliov et al., 2005; NCCES, 2006). Storing eggs in the refrigerator without any significant differences reaches a period of more than two weeks (USDA, 2007). Microwave pasteurization of eggs has effectively contributed to reducing the decline in the quality characteristics when stored in the refrigerator, due to the role of pasteurization in general and thermal laboratories in particular in preserving the internal qualitative characteristics. The white qualities were the best with increasing the pasteurization period in the microwave, and this is agree with studies (Zhang et al., 2013; Stadelman et al., 1996; Stanley and Petersen, 2017; Keener, 2017; Skowron et al., 2022).

Conclusions

We conclude from the current research that the using microwave pasteurization contributed to maintaining good quality of table eggs when stored for 8 weeks and the best process for pasteurization in the microwave is 30 sec., compared to 10 sec. Microwave pasteurization procedures gave the best internal quality characteristics of table eggs when stored in the refrigerator for a period of up to 8 weeks.

References

Al-Obaidi, F.A., S. Ch. Abood and Al-Shadeedi, Sh.M.J. (2010a). A new method using water vapor treatments for extending shelf life of table eggs during storage. Anbar Journal of Agricultural Science, 3(1): 143-155.

Al-Obaidi, F.A. (2010b). Using water vapor treatment for reducing deterioration in chemical and functional properties of table eggs during storage. Tikrit Journal of Agricultural Science, 10(2): 143-155.

Al-Obaidi, F.A. and Al-Shadeedi, Sh.M.J. (2022). Egg Science and Chemistry. 1st ed., LAP LAMBERT Publishing Company, ISBN: 978-620-5-49260-4.

Al-Shadeedi, Sh. M. J. (2009). Effect of coating table egg with natural oils, pigments and plastic coats under normal and cooled storage condition on quality, chemical, microbial and functional properties. PhD thesis, Dep. of Animal Production, College of Agriculture, University of Baghdad.

Al-Shadeedi, Sh. M. J. (2010). Effect of coating table egg with natural oils and storage condition on its shelf life. Iraqi Journal of Veterinary Medicine, 34(2): 131 – 141.

Al–Shadeedi, Sh.M.J. (2018). Study the microbial contamination of table egg containers and packages in Baghdad. 10th International Poultry Conference – Proceeding, 26 – 29 November 2018, Sharm Elsheikh – Egypt.

Al-Shadeedi, Sh.M.J. (2023). Designer egg a new and valuable items of table egg. Journal of Modern and Heritage Science, 12(1):87-100.

Dev, S.R.S., G.S.V. Raghavan, Y. Gariepy. (2008). Dielectric properties of egg components and microwave heating for in-shell pasteurization of eggs. Journal of Food Engineering 86: 207–214.

Hank, C.R., M.E. Kunkel, P.L. Dawson, J.C. Acton and F.B. Wardlaw. (2001). The effect of shell egg pasteurization on the protein quality of albumen . Poultry Sci., 80: 821-825.

Keener, K. (2017). Shell egg pasteurization. In P.Y. Hester Ed., Egg Innovations and strategies for improvements (pp. 165–175). Elsevier, Academic Press.

Morsy, M.K.; Sharoba, A.M.; Khalaf, H.H.; El-Tanahy, H.H.; Cutter, C.N. (2015). Efficacy of antimicrobial pollutant-based coating to improve internal quality and shelf-life of chicken eggs during storage. J. Food Sci. 80, M1066–M1074. [CrossRef]

National Inventors Hall of Fame, (2024). National Inventors Hall of Fame Inductee Percy Spencer and the Magnetron

NCCES, North Carolina Cooperative extension Service. (2006). The Big Chill , NC State.

North, M.O. (1984). Commercial Chicken Production Manual. 3rd ed. Avi Publishing Company. Inc. West Port.

Oliveira, G. da Silva, C. McManus, P. G. da Silva Pires and V. M. dos Santos. (2022). Combination of cassava starch biopolymer and essential oils for coating table eggs. Front. Sustain. Food Syst., https://doi.org/10.3389/fsufs.2022.957229

Sabloiv, C.M. , D.B. Frank, D.K. Keener and D.P. Curtis. (2005). Heat transfer simulation of cryogenic carbon dioxide cooling of shelleggs. Abstract.

Salman, K.Q., Mohammed R.M. and Al-Shadeedi, Sh.M.J. (2023) Effect of some natural coating of table egg on shelf life during refrigerator storage. Journal of Genetic and Environmental Resources Conservation, 11(2):103-113.

SAS Institute, 2001. SAS/STAT User's Guide for Personal Computer. Release 6.12 SAS Institute, INC., Cary, N.C., USA.

Scott, T. A. and F.G. Silversides. (2000). The effect of storage and strain of hen on egg quality . Poultry Sci., 79: 1725-1729.

Shenga, E.; Singh, R.P. and Yadav, A.S. (2010): Effect of pasteurization of shell egg on its quality characteristics under ambient storage. J. Food Sci. Technol., 47(4): 420–425.

Silversides, F.G. and T. A. Scott. (2001). Effect of storage and layer age on quality of eggs from two lines of hens. Poultry Sci., 80 : 1240-1245.

Sivaramakrishnan, S.R. (2010). Microwave pasteurization of shell eggs. MSC thesis submitted to the McGill University, Quebec, Canada.

Skowron, K., Wiktorczyk-Kapischke, N., Grudlewska-Buda, K., Walecka-Zacharska, E., & Kwiecińska-Piróg, J. (2022). Other microwave assisted processes: Microwave as a method ensuring microbial safety of food. In M. Garcia-Vaquero & G. Rajauria Ed., Innovative and emerging technologies in the bio-marine food sector (pp. 395–416).

Stadelman, W.J. and Cotterill, O.J. (1995). Egg Science and Technology. 4th ed., Food products press. An Imprint of the Haworth Press. INC. New York. London.

Stadelman, W. J., Singh, R. K., Muriana, P. M., and Hou, H. (1996). Pasteurization of eggs in the shell. Poultry Science, 75, 1122–1125.

Stanley, R.A., and Petersen, K. (2017). Microwave-assisted pasteurization and sterilization—Commercial perspective. In M. Regier, K. Knoerzer, & H. Schubert ed., The Microwave Processing of Foods (pp. 200–219). Woodhead Publishing.

Steel, R.G. and J.H. Torrie, 1980. Principle and Procedures of Statistics. 2nd ed., McGrow-Hill Book Co., Inc, New York, USA.

USDA, United State Department of Agriculture. (2000). Egg Grading Manual . MPHotline.fsis@usda.gov

Wilburn, D. (2006). Pasteurization help to kill bacteria in egg recipe dishes . Poultry Today, 1-2 . dwilburn@uga.edu

Zhang, W., Liu, F., Nindo, C., and Tang, J. (2013). Physical properties of egg whites and whole eggs relevant to microwave pasteurization. Journal of Food Engineering, 118, 62–69.