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Temperature and Storage period modulate the egg quality

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Abstract: *White leghorn eggs contains a rich protein, vitamins, minerals and fatty acids and offering a great nutritional value. It is liked by the people of all ages. Eggs are liable to perish and can use it's quality rapidly during the period between storage and consumption. The main characteristics of egg quality are thick albumen height ,yolk height , yolk index , albumen index , shape index and Haugh unit egg weight loss.The aim of the present study was to analyse the egg quality characteristics of eggs stored at different temperature.A sample of 100 eggs were obtained from laying white leghorn hens purchased from Central Poultry Development Organization (CPDO) farm located at Jaydev vihar , Bhubaneswar. All hens were kept under same feeding and management condition.All eggs were collected within 4-5 days of their lay and were randomly divided into four treatment that is control (fresh), refrigerator (4^0c), room temperature (22^0c) and high temperature (31^0c). 10 eggs were used for each treatment and were analysed for changes in the external and internal egg quality traits like egg weight, yolk index , albumen index, shape index, Haugh unit after 7, 14 and 21 days of storage.Egg weight of eggs stored in refrigerator at 4^0c were found to be significantly lower ($P < 0.05$) than the egg stored at room temperature and high temperature. From refrigerator , room temperature and high temperature , the egg weight ranged from (54.77g to 51.27g) , albumen height (0.71cm to 0.41cm) , yolk height (1.41cm to 1.01cm) and Haugh unit (85.69% to 64.08%) which decreases with the increase storage time. Thus in refrigerator egg quality was recorded better than those other condition. All the fresh egg and refrigerated egg gave significant value indicating minimal loss in quality. All the results indicates the egg stored at 4^0c are better in terms of quality as compared to egg stored at room and high temperature throughout 21 days of storage.*

Key Words: *eggs, egg quality, storage temperature , storage time , Haugh unit.*

1. INTRODUCTION:

Chicken egg is a main component of human diet . It is liked by the people of all ages. It is one of the most nutritious foods , that offersd the human being an almost complete balanced diet having protein , vitamin , mineral and fatty acids (Brugalli et al., 1998).

Eggs are also widely popular foods liked by people of all ages and because of their relatively low price and high nutrient value it is most popular among the people of low income groups (Pascoal et al. 2008 ; Menezes , 2009).
As it is one of the most widely popular food so freshness of egg is a major concerned of the consumer. Eggs are liable to perish and can loose its quality and freshness rapidly in between the period of storage and consumption. The egg quality and freshness are also affected by some environmental conditions like humidity , temperature and storage time. Several chemical and physical modifications also occur inside a egg during the storage period (Whitney et al .1999).

As compared to external quality and parameters , the internal quality starts deteriorating right from the beginning as they are laid by hens and poor storage condition also reduces the egg quality within very few days. The deterioration in quality of egg due to storage results in thinning of albumen , stretching and weakening of vitelline membrane and high water content in egg yolk (Scott and Silversides , 2000 ; Hidalgo et al., 2006 ; Karoui et al., 2006 ; Huang et al., 2012).The freshness of egg in poultry industry is judged by the quantity and quality of albumen.

It is accepted worldwide that the Haugh Unit is the measure of quality of albumen and its freshness. With the increase of age in hens the Haugh unit value of fresh egg decreases with increasing age of the hen (Ramos et al., 2008).

That is why proper storage of egg is essential to preserve its quality and also for cooking purposes. Hence in accordance with the review of current literature the most remarkable indicators that justify the freshness and the edible value of table eggs that includes egg weight loss , shape index , yolk index , albumen height , Haugh unit and shell thickness (Stadelman and Cotterill , 2005).

Barbosa et al. (2004), evaluated the effect of temperature and storage time (0,7,14,21,28,35) on egg quality characteristics , and observed that the increase of storage time causes gradual reduction in Haugh unit and weight of the egg.

Jim et al.(2012), also reported that prolonged storage time affects the quality of eggs , exerting a negative influence on the Haugh unit.

Internal egg quality also deteriorates with increased storage time (Khan et al ., 2013). He also indicated the movement of water from albumen to yolk probably reduces the albumen quality as the storage duration increases

Egg quality parameter that undergoes changes due to storage are basically albumen height, Haugh unit and yolk index .The changes happens due to evaporation of water through poresare concerned with waterloss by evaporation through the pores in the shell and carbon dioxide escapes from albumen.

Apart from human beings eggs are highly nutritious for other living organism like bacteria that can survive very well on the shell and membrane of chicken eggs. After laying eggs may come in contact with the environmental bacteria that accumulates on the shell can also penetrate inside the shell during prolonged storage time and contaminate the egg (Al- Bahry et al., 2012).

There are several factors that influence the survival of micro organism on the egg surface which include storage method and temperature condition .

Care should be taken while storing the eggs as improperly stored eggs can facilitate bacterial growth on the shell and some of them penetrates inside the membrane of edible eggs. Consumption of these contaminated eggs with bacteria can cause serious food poisoning.

The present study was conducted to determine the impact of different storage conditions on egg production parameters.

2. MATERIALS AND METHODS:

Sample acquisition

About 100 freshly laid eggs of White leghorn strain were purchased from C.P.D.O(Central Poultry Development Organization) farm located at Jaydev vihar , Bhubaneswar and brought to the Zoology laboratory of CUTM, Bhubaneswar for further investigation. The climatic conditions of Bhubaneswar are as follows : It has a great climate and seasonal variation . It has a very short period of rainfall 3- 4 months giving 1505mm per annum with a long dry season of about 7 – 8 months. The medium temperature could be as low as 20^0c during the winters that is October to February . During summers the temperature ranges from 40^0c to 42^0c and the annual relative humidity about 70.0%.

Procedure

Fresh eggs were measured within a day and each of 10 sampled eggs were stored in refrigerator at 4'c for 7 ,14 and 21 days and same at room temperature 22^0c and at high temperature of
35^0 c .Thus 100eggs were collected and used in 9 treatment (3storage period and 3 storage temperature) and one group of fresh egg with 10 eggs examined in each.

Physical Characterization

The eggs were selected and the following parameters was determined.

Egg weight

Weight of eggs were determined using digital weighing balance (Aczet _model_CY224). The weight of each egg were recorded.

Shape index

Shape index (SI) is the primary method of measuring the egg quality which is obtain by the formula
Shape index = (width of egg / length of egg) X 100

Yolk index

The yolk index (YI) is the measurement of internal quality of egg which is measured by the use of tripod micrometer and the diameter of the egg yolk is measured by the use of vernier caliper.The formula to calculate the yolk index is

YI= height of egg yolk (cm) / diameter of egg yolk (cm).

Albumen index

The Albumen index (AI) is the measurement of the egg quality that is measured by the help of tripod micrometer and the width of the thick albumen is measured by the help of vernier caliper

Haugh unit (HU)

Primarily, the Haugh unit is a measure of egg protein quality, based on the height of egg albumen . For measuring the Haugh unit the egg was broken on a flat smooth surface plate by cracking in the middle of egg avoiding the breakage of yolk and by the use of tripod micrometer the height of thick albumen was measured. The formula to calculate Haugh unit is

$HU=100 \log(H-1.7W^{0.37} + 7.57)$

Where HU= Haugh unit

H= thick albumen height (mm)

W= Egg weight (g)

The experimental data was obtained by statistical analysis processed with the help of analysis of variance (ANOVA) and the significant differences between the means were calculated.

3. RESULTS AND DISCUSSIONS:

The effect of storage period and temperature on egg quality traits were found to be significant ($P< 0.05$) for all traits except shape index and egg width. The mean ± standard errors of fresh eggs and the different storage methods (room temperature – 22^0c , high temperature – 31^0c and refrigerator – 4^0c) has been presented in Table no. 1, 2 and 3 respectively . Egg quality traits of eggs at different storage period and conditions were presented in fig. 1 to 4

In the present investigation it was noticed that egg width , yolk width and albumen width increased at different storage period and temperature ($p < 0.01$) . However, the interaction affect between storage period and temperature were significant for egg weight , albumen height , yolk height , yolk index , albumen index and Haugh unit($P<0.05$).

In the present study , the weight of the eggs before storage was 54.77g while the weights after storage were 54.42g,53.98g and 54.77g in room temperature , high temperature and cold temperature respectively. It was found that the means at high temperature and room temperature were substantially different from the fresh eggs. For consumption after 21 days of storage, eggs stored at high temperature (31^0c) are not recommended as a substantial decrease ($P<0.05$) from 54.77 g to 51.27 g can be noted. These decreases in egg weight with storage has been observed by Samli et al. (2005) who noted a decrease in weight with in 10 days of storage at 29^0c . refrigerated and room temperature had lower (P0.05) egg weight loss probably due to less moisture loss from the eggs as reported by ACIAR(1998).decrease in egg weight with storage are in agreement with published reports of Hasan and Okur (2009). Siyar et al (2007) note substantial ($P<0.001$) decrease in egg weight of 0.36 g and 0.57 g respectively within 7 and 14 days of storage, with increased storage duration, decrease in egg weights, loss of carbon dioxide, ammonia, nitrogen, hydrogen sulfide gas and egg water (Dudusola,2009; Alsobayel and Abadry , 2011; Jin et al ., 2011). Silversides and Villeneuve (1994) and Scott and Silversides (2000) have recorded similar weight losses. Weight losses were not the same for all storage methods, as 4^0c refrigerated eggs did not loose as much solvent as in room temperature.

The album and yolk width of new, room temperature substantially vary ($P<0.05$) from those refrigerated eggs. The yolk width values in room and high temperature is higher in the present study because the amount of water migration from albumen to yolk is high which helps to increase yolk width, which is in agreement with Brake et al.(1997).

The effect of storage time and temperature on shape index did not effect significantly ($P<0.05$). In the present study it is observed that the shape index at cold temperature increased from 79.56 of fresh egg to 83.82 stored till 21 days whereas at room temperature the shape index increase from 81.36 of fresh egg to 83.39 stored till 21 days and at high temperature the shape index increase from 82.07 of fresh egg to 86.7 stored till 21 days, these result are also supported by Woodard (1982) ,Song et al (2000) , Tilki and Saatci (2004) who also observed that shape index increase with storage time and temperature non significantly. However Raji et al.(2009) noted that storage time and temperature did not effect the shape index significantly.

A remarkable deterioration were observed in albumin and yolk height of the eggs stored from 0 to 21 days at different temperatures in the present study. The albumen and yolk height of fresh eggs did not differ in refrigerated eggs from fresh to 7 days but differed remarkably and significantly ($P<0.05$) from 14 to 21 days of storage. At room temperature and high temperature the yolk height differed significantly from fresh eggs to 21 days .This is in agreement with Mountney (1976) who enumerates that as the albumen and yolk becomes watery there is a loss of albumen and yolk height thus declining the egg quality. The present investigation is an agreement with Shin et al (2012) who also opined a significant decrease of albumen height and yolk height during 10 days of storage at room and high temperature. Samli et al. (2005) in their study also reported that albumin height decreased with in 10 days of storage period. The general decline in albumin and yolk quality with increase storage period is in agreement with the findings of Monira et al.(2003) and Miles and Henry (2004).

Yolk index values in the present study is found to decrease with increase in storage period . The initial yolk index for the fresh eggs was determined to be 0.56 . Ihekronye and Ngoddy(1985), suggested that the yolk index of fresh

egg varies between 0.30 -0.50 with a mean value of 0.42 . In the present study significant reduction($P<0.05$) in the yolk index value were observed during the storage period, at room temperature the yolk index value ranged from 0.5 to 0.3 , whereas the yolk index in refrigerated eggs at different storage time decreased significantly ($P<0.05$) from 0.5 to 0.4 and , at high temperature significant deterioration in the yolk index values at different storage time were noticed to be 0.5 to 0.3. So the eggs stored under refrigeration temperature maintained higher yolk index while those stored under high temperature and ambient conditions . According to Stadelman and Cotteril (2007) the decay of carbonic acid makes the albumen watery. The yolk extracts water from the albumen across the vitelline membrane in an effort to equalize the amount of saturation between egg white and egg yolk resulting in yolk swelling, which in effect exerts amount on the vitelline membrane (Watkins 2007).

This pressure eventually causes the yolk to change from spheroid shape to a round flabby shape mass. So the rate of changes in the yolk is a function of temperature and movement of carbondioxide through the shell.

The dimensional appreciation of albumen offers important information about the freshness of eggs Jones and Musgroove,(2005).The storage conditions influenced the eggs albumen index significantly at ($P<0.05$) in the present study. The mean values of albumen index obtained for the fresh eggs before storage were 10.42± 0.07 ,and after storage for 7 days, 14 days and 21 days at room temperature is recorded as 9.03 , 8.32 and 7.43 respectively ,whereas the values obtained from those stored in refrigerator for 7, 14 and 21 days ranged from 10.26, 9.88 and 8.8 respectively and the values obtained at room temperature were observed as 9.03, 8.32 and 7.43 respectively. So in all the storage conditions the values of the present study reveals that there is a gradual declination of albumen index and the deterioration is found to be maximum in case of eggs stored at high temperature. Similar results were also opined by Jones and Musgroove (2005) in chicken as well as quail eggs. Furthermore, gradual decline in the values of the albumen index of eggs during storage was evident in eggs stored under refrigeration in contrast to albumen index of eggs stored under ambient condition (Raji et al. 2018).

Otles and Hisil (2004) reported that room temperature storage of eggs resulted in albumen mottling and preferred metabolic practices that resulted in a decrease in albumen efficiency, while refrigerated eggs had the lowest decrease in albumen index at the end of storage. Due to the lower storage temperature, water transfer from albumen to yolk is limited, leading to high quality albumen (Brake et al., 1997).

Yolk index is an egg content metric dependent on the state of the yolk membrane, which indicates consistency for fresh eggs between 0.33 and 0.5 (Stadelman et al., 1996; Popoola et al., 2015). Ageing reduces yolk appearance, weakens the yolk membrane and decreases the egg yolk index value (Keener et al., 2006). Nonetheless, a drop in the index of egg yolks as the storage cycle continues may be due to aging or may be due to passage of CO2 and moisture into the shells of the eggs triggering albumen, yolk and egg weight changes (Stadelman and Cotterill, 2005). It may also be that the fibrous glycoprotein ovomucin in the egg breaks down (Dudusola, 2009).

Haugh unit determines the freshness of eggs and albumen quality and also confirms the suitability for consumption. The results of Haugh unit (HU) of eggs at room temperature , at high temperature and at low temperature (refrigerator) are presented in Table-1,2 and 3 respectively. In the present study it was observed that Haugh Unit of fresh eggs declined significantly ($P<0.05$) with increasing storage time at different storage conditions .Haugh Unit might have reduced due to decrease in thick albumen height, because during storage, the ovomucin- complex breaks down that helps to increase the pH of eggs. The results of the present study is in agreement with Morais et al.(1997) ,who observed the reduction in Haugh Unit of eggs at 21 days of storage . Our findings are also supported by Scott and Silversides (2000) , Samli et al. (2005) and Akyurel and Okur (2009) as they all reported gradual decline of Haugh Unit with increasing storage time and conditions of eggs. Haugh index not only determines the suitability of eggs for consumption, but also serves as an indicative factor for incubation as it defines the quality of eggs based on dense albumen index and eggs (Berardinelli et al., 2008). Among the storage conditions considered, storage under refrigeration had limited effect on the Haugh Unit of eggs, and this might be as a result of their storage at reduced temperature (4oC) which limited metabolic activities. A similar finding was reported by Gavril and Usturol (2011) who did research on effects of temperature and storage time on hen eggs quality. However, eggs having Haugh Unit of 30 and below are not suitable for consumption (USDA, 2000). Comparitively higher values obtained after storage in refrigeration indicated that eggs could be stored under those conditions for over six weeks.

4. CONCLUSION:

The findings show that egg quality is influenced by the process and duration of the storage. Rapid degradation of the quality of the eggs stored at room temperature and high temperature renders them unfit for use after three weeks of storage. Processing of eggs under refrigeration in contrast with processing at ambient temperature avoids loss of quality. In tropical countries, where ambient temperature ranges from 25 to 30 ° C, egg storage should not exceed two weeks before consumption to assess fresh quality of the eggs. Taking into account the various quality parameters evaluated, eggs were better preserved in refrigerators compared with ambient conditions.

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REFERENCES:

1. Akyurek H. and Okur A A . 2009. Effect of storage time, temperature and hen age on egg quality in freerange layer hens. J. Anim. Vet. Adv., 8: 1953-1958.
2. Al- Bahry S N , Mahmoud I Y, Al -Musharafi S K and Al- Ali MA .2012 ."Penetration of Spoilage and Food Poisoning Bacteria into Fresh Chicken Egg: A Public Health Concern." Global Journal of Bio- Science and Biotechnology Science and Nature. Society for Science and Nature. 1.1 : 33 - 39.
3. Alsobayel AA and Albadry MA.2011.Effects of storage period and strain of layer on internal and external quality of eggs marketed in Riyadh area J. Saudi Soc Agri Sci,10:41-45.
4. ACIAR . 1998.Measurements and maintenance of duck and hen egg quality in Vietnam. Australian Centre for International Agricultural Research . Research note RN 23 12/99.
5. Barbosa NAA , Freitas E R, Sakomura , NK. 2004. Efeito da temperatura e do tempo de armazenamentonaqualidade internal de ovos de poedeirascomerciais. Brazilian Journal Poultry Science . 6 :60-65 .
6. Brake J ,Walsh T J, Benton C E, Meijerhof R and Pennalva G .1997. Egg handling and storage. Poultry Science 76(1):144-151.
7. Brugalli I , Rutz F, Zonta E P l.1998. Efeito dos niveis de oleo e proteina da dietasobre a qualidadeinterna de ovos, emdifferentescondicoes e tempo de armazenamento. RevistaBrasileira de Agrociencia, 4(3)187-190 .
8. Dudusola IO.2009. Effects of storage methods and length of storage on some quality parameters of Japanese quail eggs . Tropicultura,27(1):45-48.
9. Haugh RR.1937. The Haugh unit for measuring egg quality.US Egg Poult. Mag.43 522-555, 572-573.
10. HammershojM, Larsen LB, Andersen AB, Quvist KB .2002. Storage of shell eggs influences the albumen gelling properties. LWT- Food Sci Technol, 35:62-69.
11. Hasan A and Okur AA. 2009. Effect of storage time , temperature and hen age on egg quality in free range layer hen. Journal of Animal and Veterinary Advances , 8(10) 1953-1958.
12. Hidalgo A, Rossi M, Pompei C .2006. Estimation of equivalent egg age through furosine analysis. Food Chem 94:608- 612.
13. Huang Q, Qiu N, Ma MH ,Jin YG, Yang H, Geng F , Sun SH. 2012. Estimation of egg freshness using S-ovalbumin as an indicator. Poultry Science, 91:739- 743.
14. Ihekoronye and NGoddy AI .1985.Integrated Food Science and Technology for Tropics.Macmillan press London.
15. Jin YHKT, Lee WI ,Lee and Han YK. 2011.Effects of storage temperature and time on the quality of eggs from laying hens at peak production. Asian- Aust. J. Anim.sci.24:279-284.
16. Jones DR and Musgroove MT.2005. Effects of extended storage on egg quality factors. Poultry Science. 84:1774-1777.
17. Keener, KM, McAvoy, Foegeding PA, Curtis, Anderson KE, Osborne .2006.Effect of testing temperature on internal egg quality measurements. Poultry Science. 85:550-555.
18. Karoui R, Kemp's B ,Bamelis F, De Ketelaere B , Decuypere E , De Bardemaeker J. 2006. Methods to evaluate egg freshness in research and industry: A review. Eur Food Res Technology 22: 727- 732.
19. Khan MJA, Khan A, Bukhsh ,Abbass MI and Javed .2013. Effect of different storage period on egg weight , internal egg quality and hatchability characteristics of Fayumi eggs. ltal.J.Anim.Sci., 12:51-56.
20. Menezes PC ,Cavalcanti VFT, Lima ER .2009. Aspectosprodutivos e economicos de poedeirascomerciaissubmetidas a diferentesdensidades de alojamento. RevistaBrasileira de Zootecnia, 38(11) 2224-2229 .
21. Miles RD , Henry PR .2004. Effect of time and storage condition on albumen quality of eggs from hens fed with Vanadium. Journal of Applied Poultry Research. 13(4): 619-627.
22. Monira KN ,Salhuddin M and Miah G.2004. Effect of breed and holding period on egg quality characteristicsof chicken. International Journal of Poultry Science. 2:261-263.
23. Mountney GJ.1976. Poultry production technology. 2nd Edition.AVI publishing company ,westport Connecticut.
24. Morais C F A, Campos E J and Silva T J P.1997. Qualidade interna de ovos commercializadoseFem differentes supermercados na cidade de Uerlandia. Arquivo Brasileiro de Medicina Vetrinaria e Zootecnica ,49:365-373.

25. Otles S and Hisil Y. 2004. The vitamin B2 content of fresh and stored hen eggs. Electronic Journal of Polish Agricultural Universities. Series Food Science and Technology, 2(07).
26. Pascoal LAF, Bento Junior BA , Santos , WS. Qualidade dos ovoscommercializa dosemdifferentesestabelecimentosnacidade de Imperatriz- MA. RevistaBrasileira de saude e Producao Animal, 9(1) 157- 171.
27. Popoola MA, Alemede CI, Aremu A and Ola SI. 2015. Morphometric Parameters of whole egg and Egg Yolk of five Nigerian Domesticated Avian Species. Journal of Agriculture and Veterinary Science, 8: 41-45. DOI: 10.
28. Raji AO , Aliyu J , Igwebuike J U and Chiroma S.2009. Effect of storage methods and time on egg quality traits of laying hens in a hot dry climate. ARPN journal of Agricutural and Biological Sciences . 4(4):1-7.
29. Raji A, Tolani D, Akimsu R and Aruna TE .2018. Comparitive evaluation of some properties of chicken and Japanese quail egg subjected to different storage methods. Poultry Science Journal, 6(2):155-164.
30. Ramos KCBT, Flor HR, Camargo AM .2008. A spectos qualitativos de ovoscomerciaisarmazenadosem differentesembalagens. In: Encontro Latino Americano de Pos Graduacao, 8:1- 4.
31. Samli, H.E., A. Agma and N. Senkoylu, 2005. Effects of storage temp and temperature on egg quality in old laying hens. J. Appl. Poult. Sci., 14: 548-553.
32. Scott TA. and Silversides FG. 2000. The effect of storage and strain of hen on egg quality. Poultry Science, 79:1725- 1729.PMID: 11194033
33. Silversides FG, Budgell K .2004 .The relationship among measures of egg albumen height, pH, and whipping volume. Poultry Science, 83:1619- 1623.
34. Silversides FG ,Villeneuve P .1994. Is the Haugh Unit correction for egg weight valid for eggs stored at room temperature? Poultry Science ,73:50-52.
35. Siyar HAS , Alirabi H, Ahmadi A and Ashori N.2007. Effect of different storage conditions and hen age on egg quality parameters. Aust Poult Sci Symp. 19:106-109.
36. Song KT, Choi SH and Oh HR. 2000 . A Comparison of egg quality of pheasent, chukar, quail and guineafowl. Australian Asian Journal of Animal Science .7: 986-900.
37. Stadelman WJ and OJ Cotterill .2005. Egg Science and Technology.4th Edition. Food Products Press. New York.
38. Stadelman WJ and OJ Cotterill .2007. Egg Science and Technology.4th Edition. Haworth Press. Inc :New York.
39. Stadelman WJ .1996. Pasteurization of eggs in the shell. Poultry Science, 75:1122-1125
40. Tilki M and Saatci M .2004. Effect of storage time on external and internal characteristics of Patridge*(Alectoris gracea*) eggs. Revue Medicine Vetrinary 155(11): 561-566.
41. USDA. 2000. United States standards, grades and weight classes for shell eggs. AMS, USDA, Washington DC.
42. Watkins B A. 2007. The nutritive value of egg. In W.J. Stadelman and O.J. Cotterill (eds.) Egg Science and Technology 4th Edition. Haworth Press Inc., New York, pp. 177 – 194.
43. Whitney NE and Rolfes SR .1999. Understanding Nutrition. Eighth Edition. An International Publishing Company New York.
44. Woodard A E .1982. Raising Chukar Patridge. Department of Avian Sciences , University of California, Davis, CA 95616. Available:http://animalscience.ucdavis.edu/avian/chukar, pdf

Table 1: External and internal egg quality traits of egg affected by storage time in room temperature

room temperature				
	fresh egg	7days	14days	21 days
egg weight	54.77 ± 0.36^{a}	54.42 ± 0.45^{ab}	53.97 ± 0.72^{b}	53.36 ± 0.69^{b}
egg width	4.36 ± 0.09^{a}	4.41 ± 0.12^{ab}	4.45 ± 0.11^{ab}	4.47 ± 0.09^{ab}
egg length	5.48 ± 0.14^{a}	5.42 ± 0.12^{a}	5.38 ± 0.12^{ab}	5.36 ± 0.10^{ab}
albumen height	0.71 ± 0.03^{a}	0.63 ± 0.03^{b}	0.59 ± 0.03^{c}	0.53 ± 0.01^{c}
albumen width	6.81 ± 0.11^{a}	6.97 ± 0.14^{a}	7.09 ± 0.11^{b}	7.13 ± 0.14^{bc}
yolk height	1.41 ± 0.06^{a}	1.32 ± 0.08^{ab}	1.21 ± 0.06^{a}	1.08 ± 0.04^{ac}
yolk width	2.5 ± 0.07^{a}	2.61 ± 0.10^{ab}	2.74 ± 0.11^{ab}	2.83 ± 0.14^{ac}
shape index	79.56 ± 0.69^{a}	81.36 ± 0.47^{b}	82.71 ± 0.51^{b}	83.39 ± 0.63
yolk index	0.56 ± 0.03^{a}	0.5 ± 0.06^{a}	0.44 ± 0.06^{b}	0.38 ± 0.04^{c}
albumen index	10.42 ± 0.07^{a}	9.03 ± 0.07^{b}	8.32 ± 0.11^{c}	7.43 ± 0.14
Haugh unit	85.69 ± 0.63^{a}	81.36 ± 0.32^{ab}	78.06 ± 0.40	73.76 ± 0.50

Superscript a,b,c means within rows differ significantly (P<0.05> from each other

Table 2: External and internal egg quality traits affected by storage time in high temperature

high temperature				
	fresh egg	7days	14days	21days
egg weight	54.77 ± 0.36^{a}	53.98 ± 0.23^{ab}	52.84 ± 0.15^{ab}	51.27 ± 0.26
egg width	4.36 ± 0.09^{a}	4.44 ± 0.14^{ab}	4.51 ± 0.20^{ab}	4.58 ± 0.27^{ab}
egg length	5.48 ± 0.14^{a}	5.41 ± 0.24^{ab}	5.36 ± 0.13^{abc}	5.28 ± 0.15^{bc}
albumen height	0.71 ± 0.03	0.58 ± 0.06	0.49 ± 0.06	0.41 ± 0.05
albumen width	6.81 ± 0.11^{a}	6.99 ± 0.29^{a}	7.09 ± 0.11^{b}	7.16 ± 0.23^{b}
yolk height	1.41 ± 0.06^{a}	1.29 ± 0.29^{a}	1.18 ± 0.10^{b}	1.01 ± 0.07^{b}
yolk width	2.5 ± 0.07^{a}	2.64 ± 0.19^{a}	2.79 ± 0.21^{ab}	2.91 ± 0.20
shape index	79.56 ± 0.69	82.07 ± 0.17	84.14 ± 0.44	86.74 ± 0.27
yolk index	0.56 ± 0.03^{a}	0.48 ± 0.04^{ab}	0.42 ± 0.03^{ab}	0.34 ± 0.06
albumen index	10.42 ± 0.07	8.29 ± 0.04	6.91 ± 0.20	57.26 ± 0.03
Haugh unit	85.69 ± 0.63	77.33 ± 0.49	70.68 ± 0.33	64.08 ± 0.36

Super script a,b,c means within rows differ significantly (P<0.05> from each other

Table 3: External and internal egg quality traits affected by storage time in cold temperature

cold temperature				
	fresh egg	7days	14days	21days
egg weight	54.77 ± 0.36^{a}	54.77 ± 0.36^{a}	54.68 ± 0.26^{abc}	54.2 ± 0.31^{ac}
egg width	4.36 ± 0.09^{a}	4.36 ± 0.09^{a}	4.42 ± 0.10^{ab}	4.51 ± 0.08^{abc}
egg length	5.48 ± 0.14^{a}	5.48 ± 0.14^{a}	5.43 ± 0.16^{a}	5.38 ± 0.13^{ab}
albumen height	0.71 ± 0.03^{a}	0.71 ± 0.03^{a}	0.69 ± 0.06^{b}	0.62 ± 0.06^{b}
albumen width	6.81 ± 0.11^{a}	6.92 ± 0.17^{ab}	6.98 ± 0.24^{ab}	7.04 ± 0.11
yolk height	1.41 ± 0.06^{a}	1.38 ± 0.11^{ab}	1.29 ± 0.06^{abc}	1.18 ± 0.05^{ac}
yolk width	2.5 ± 0.07^{a}	2.56 ± 0.20^{ab}	2.63 ± 0.20^{abc}	2.74 ± 0.21^{ac}
shape index	79.56 ± 0.69^{a}	79.56 ± 0.69^{a}	81.39 ± 0.21^{ab}	83.82 ± 0.20^{c}
yolk index	0.56 ± 0.03^{a}	0.53 ± 0.04^{a}	0.4 ± 0.03^{ab}	0.43 ± 0.07^{ab}
albumen index	10.42 ± 0.07^{a}	10.26 ± 0.25^{ab}	9.88 ± 0.15^{c}	8.8 ± 0.19
Haugh unit	85.69 ± 0.63^{a}	85.69 ± 0.63^{a}	84.49 ± 0.18^{b}	80.11 ± 0.18

Super script a,b,c means within rows differ significantly (P<0.05> from each other

Fig. 1. Egg quality traits of eggs at different temperature of fresh egg

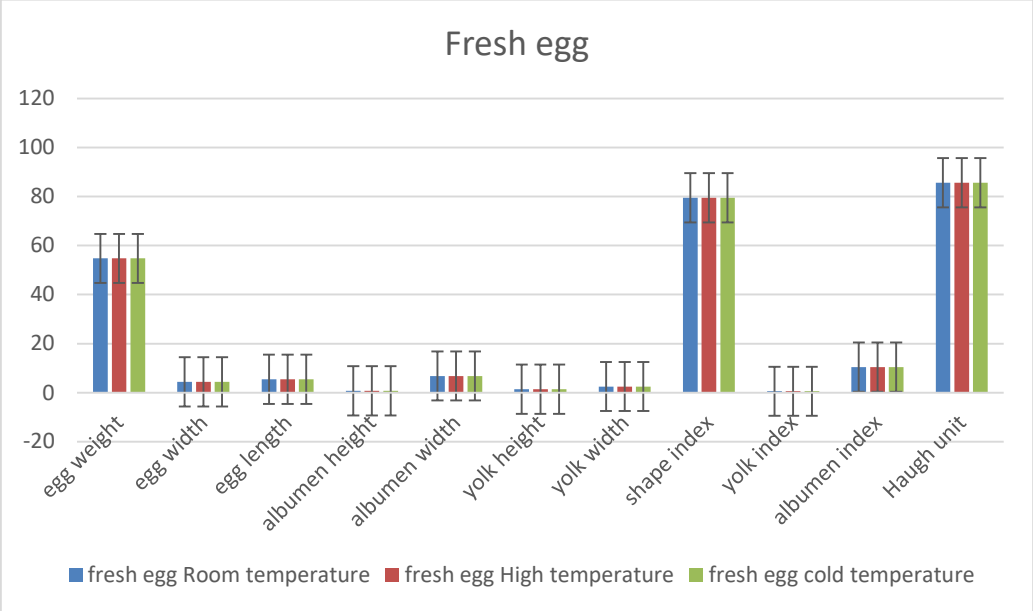

Fig. 2. Egg quality traits of eggs at different temperature for 7 days

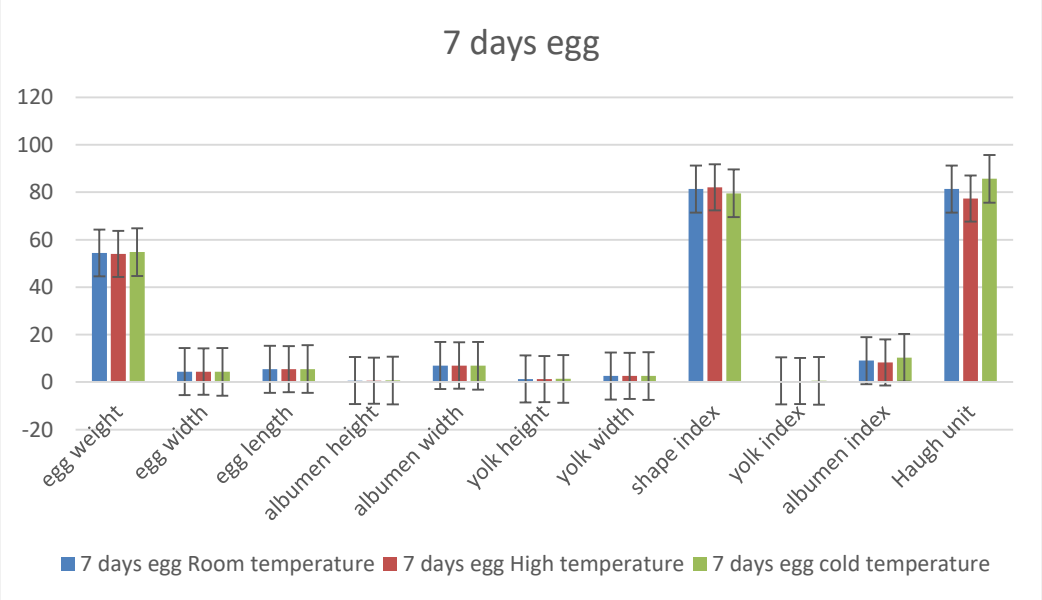

Fig. 3. Egg quality traits of eggs at different temperature for 14 days

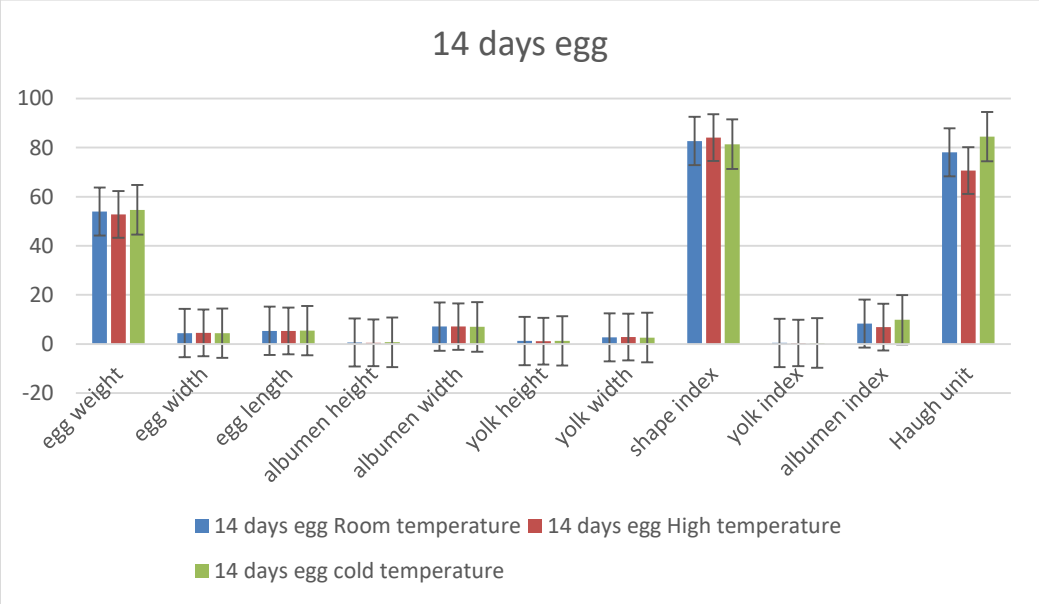

Fig. 4. Egg quality traits of eggs at different temperature for 21 days