KEEPING QUALITY OF SHELL EGGS DURING SUMMER

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "KEEPING QUALITY OF SHELL EGGS DURING SUMMER" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,
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CERTIFICATE

Certified that this thesis entitled "KEEPING QUALITY OF SHELL EGGS DURING SUMMER" is a record of research work done independently by Sri. R.Radhakrishnan Nair under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

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INTRODUCTION

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India has made commendable progress in poultry production during the last two decades. The value of poultry production increased from Rs. 650 millions in 1961 to Rs. 6,630 millions in 1980; the laying stock from 35 million to 88 millions and egg production from 2,340 millions to 12,5000millions. Perapita availability of eggs for the same period increased from 5.3 to 19 (Amon, 1981).

Concurrent with the increased egg production, marketing problems have also increased. Production in small lots, distance to best markets, lack of adequate holding and transportation facilities, breakages and high environmental temperature have been serious problems in marketing. Added to it, there are seasonal variations in production and changes in total demand for eggs with surplus eggs in one season and scarcity in other. The poultry man, under the present market conditions of demand and supply, is forced to part with his produce at a cheaper rate during surplus periods resulting in lowered returns per unit of product. It has been reported that, in Madras city during the period from 1974 to 1980 the average wholesale price of layer mash had gone up

by 3.06 per cent while the egg price registered a drop of 8.64 per cent (Amon, 1961). In India, the greater portion of the egg production is concentrated in rural areas and in small lots and the major consuming areas are the larger towns and cities far away from the points of production. This involves greater lapse of time between production and consumption and consequent quality decline.

The extent of quality deterioration of eggs marketed in India has not been assessed accurately. Panda (1966b) expressed the fear that one out of every four eggs produced in India did not reach the consumer in good condition. He had also reported that the quality of eggs marketed in the country is usually poor in summer and rainy seasons in comparison to winter months.

Production of clean eggs and preservation of quality in eggs are some of the possible solutions to theproblem. Refrigeration has been widely accepted as an ideal method of preservation of eggs all over the world. But this method cannot be considered as the ideal choice of preservation of shell eggs in India for the present, in view of the inadequate refrigeration facilities and also due to the economic backwardness of the large number of small scale producers.

Thus, in a country like India, maintenance of quality of eggs is beset with many problems. If any method of preservation of eggs in India is to be of value, it should be to the exclusion of cold storage or refrigeration as the basis. Therefore, the methods that can be tried and adopted in the preservation of eggs have to confine to such methods as oil treatment, lime sealing, thermostabilization, water glass method and overwrapping. Of these, lime sealing may be regarded as a more simpler and economic method which could be followed by the average producer.

In the present work an effort is made to determine the length of time the shell eggs can be stored at prevailing room temperature during summer months without marked deterioration in quality and to assess the effectiveness of lime sealing as a method of short-term preservation.

The work also envisages to evaluate the comparative efficacy of lime sealing and cold storage in preserving quality of eggs.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The problem of maintenance of egg quality being universal, has attracted the research as early as the second half of 18th century.

Effect of Temperature, Humidity and Time on Egg Quality.

Wilhelm and Heiman (1938) reported the effect of different temperatures on the change in albumen index. It was observed that after a 30 per cent loss had occured a temperature of 30°F retarded further loss in albumen quality.

Funk (1944) was the first to make an extensive study on the effect of temperature and humidity on keeping quality of eggs and reported that thick albumen was converted to thin albumen very slowly at temperatures of 30°F and 50°F, but quite rapidly at temperatures of 80°F and 100°F. For short holding periods, humidity had little influence on albumen deterioration, but did affect the amount of evaporation.

A field survey of ranch egg quality by Lorenz and Newlon (1944) demonstrated that egg room temperature and frequency of delivery to the market were the important factors affecting the egg quality. The quality of eggs

stored at 45°F for ten days was practically the same as those stored at 80°F for four days.

Tower and Lipp et al. (1950) in a study convincingly demonstrated the advantage of holding eggs at 55°F over holding in farm egg coolers and the advantage of the latter over room temperature. The percentage of grade 'A' eggs at the end of the week averaged 40.2 to 72 for the refrigerator, 14 to 58 for case type coolers, 22.3 to 59.9 for evaporator type coolers and 13.5 to 40.1 for room temperature. Overall percentages of grade 'A' eggs were as follows; eggs held for one day, 76; two days, 68; three days, 64; four days, 56; five days, 53; six days, 43 and seven days, 35.

In a study of egg quality in market channels it was found that the rate of loss in albumen quality and the candling grades generally decreased from winter to spring to summer. The increased rate of loss was directly related to the increased temperature in the egg holding room (Jensen and Stadelman, 1951).

According to Dawson and Hall (1953) the greatest decline in albumen quality occured during the first three days regardless of the temperature. Temperature of 60°F or lower was found to be practical for normal farm holding of eggs.

In a temperature-time study on egg quality by Fry and Newell (1957) it was observed that eggs stored at 60°F for one day were lower in quality than those stored for seven days at 30°F. Eggs stored at 90°F for one day were lower in quality than those stored at 60°F for seven days.

For oil treated eggs relative humidity of the storage area had no economically significant effect on albumen quality as expressed in Haugh unit scores. In the case of washed and oiled eggs, humidity had a statistically significant effect, with high humidity being more beneficial in maintaining albumen quality. The temperature of storage significantly influenced albumen quality irrespective of the treatments or humidity (Kerslund, et al 1936). Strain and Johnson (1936) suggested that the decline in quality of freshly laid eggs was more due to physiological changes taking place as the egg production progresses than to changes in the environmental temperature. Sreenivasulu Reddy et al. (1969) studied the effect of two relative humidities (50 and 75%) on the changes in weight and internal quality of eggs during storage at room temperature and the effectiveness of lime sealing and oil coating in minimising these changes. They found significant difference in loss of weight on shell eggs due to different relative

humidities. Humidity differences were not found to have much effect on the rate of quality deterioration of oil coated and lime sealed eggs.

Physico-chemical Changes of Egg Quality Deterioration

The physical changes that occur to the egg when held are mainly loss in weight, thinning of thick albumen, passage of water from white to yolk, weakening of the vitelline membrane and increased albumen pH. Researchers have tried to explain these physical changes on the basis of biochemical reaction that may occur in the egg components.

Holst and Almquist (1932) demonstrated that the thick albumen became thin as the fresh egg aged.

In a study, Almquist and Lorenz (1932) reported that the characteristic gel structure of the egg albumen was due to the protein fraction ovomucin.

The theory of egg white thinning put forward by Hawthorne (1950) suggested that the thinning resulted from the slow insolubulation of ovomucin by combination with lysozyme.

The egg white moiety reportedly responsible for firmness of thick white was found to be ovomucin and very small changes in properties of ovomucin will cause gross change in firmness

of thick albumen. It was also shown that the cause of thinning of egg white during storage exists or arises in the egg white itself (Feeney et al. 1950).

In another study, Feeney et al. (1952) observed that lysozyme activity decreased about 20 to 25 per cent in egg white when shell eggs were stored at 2°C for 45 days or 35°C for 15 days. This decrease in activity could be considered to support the theory that thinning is caused by the formation of an insoluble protein complex.

Decrease in lysozyme activity of shell eggs with storage time was also reported by Wilcox and Cole (1954).

A decrease in electrostatic forces between lysozyme and ovomucin is a factor in egg white thinning. The lysozyme concentration itself may be a factor governing the degree of electrostatic attraction (Cotterill and Winter, 1955). Fromm and Mastone (1962) reported that during storage the vitelline membrane weakened and became more elastic. The movement of water and stretching of the vitelline membrane of the yolk has been explained as a result of weakening of the membrane caused by increased pH (Fromm, 1966).

Changes in concentration of ovomucin during storage of shell eggs at room temperature have been followed in a study by Baliga et al. (1970). The concentration of ovomucin in

thick albumen was nearly four times that in thin albumen. This finding is in conformity with earlier findings of Mc Nally (1934).

Donovan et al. (1970) provided evidence that the ovomucin was composed of extended glycoprotein chains held together by disulphide linkages. They demonstrated that the hydrolysis of these disulphide bonds caused a decrease in the viscocity of the ovomucin.

Weight loss.

Weight loss is one of the major physical change that occurs in the egg as it ages and is dependant on the porosity of the shell and environmental conditions existing outside the shell.

According to Dunn (1923) the rate of loss in weight of shell eggs appeared to decrease slightly with the time the eggs are held. On the effect of humidity on egg quality, Funk (1944) reported that, for short holding periods humidity had little influence on albumen deterioration but did affect the evaporation.

Taylor (1945) found, that the first egg of a clutch tends to have a lower porosity than the other eggs in the same clutch. This finding can be related to the report of Smith (1932) who gave the probability that eight eggs in

every hundred would have weight losses 30 per cent greater or smaller than the mean value.

Quinn et al. (1945) observed that the per cent of weight loss tended to decrease as initial egg weight increased. This view is in agreement with earlier observations of Dunn (1923).

Lower temperatures maintained egg quality and weight with less loss than did the higher temperatures. Relationships and correlations between water loss and Haugh unit score have been established by Moeller (1957) who found it to be r = -0.210. He also concluded that the water loss and egg weight were not significantly correlated with albumen quality deterioration.

Bornstein and Lipstein (1962), in a study involving approximately 2,000 eggs, concluded that per cent weight loss showed a linear regression on time ; the slope of the line varying directly with the temperature.

Kumar et al. (1968) reported a percentage weight loss of 1.4, 1.915 and 2.968 when the eggs were lime treated and held at room temperature (28°C and RH 58.5%) for 14, 21 and 28 days respectively. Corresponding figures for untreated controls were 3.338, 5.254 and 7.586.

In a study involving comparison of eggs treated with processed coconut oil and those treated with commercial egg

coating oil, Verma and Sathe (1970) reported weight losses for 20 days storage at room temperature of 35°C as 0.96 per cent for eggs treated with processed coconut oil, 1.7 per cent for eggs treated with commercial egg coating oil and 12.6 per cent for those kept at room temperature without any treatment.

Lochmba *et al*. (1971) recorded a weight loss of 2.84 per cent, 6.69 per cent, 7.20 per cent and 9.82 per cent when eggs were held for 1, 2, 3 and 4 weeks at temperature and relative humidity of 32°C and 68 per cent relative humidity, 36°C and 70 per cent relative humidity, 35°C and 59 per cent relative humidity and 42°C and 66 per cent relative humidity respectively.

Khandlekar *et al* (1971) reported a weight loss percentage in untreated eggs as 1.20, 2.28 and 4.00 for 5, 10 and 15 days of storage at room temperature of 28.4°C and 75.1 per cent relative humidity.

Jairaj *et al*. (1972) held eggs for 15 days at 31.9°C and 42.5 per cent humidity and noticed a percentage weight loss of 7.31 for clean eggs and 8.39 for dirty eggs and 8.05 for clean eggs washed and 8.11 for dirty eggs washed respectively.

Role of rate of air movement as a factor affecting the weight loss in eggs has been demonstrated by Maurer (1974) and reported higher weight loss with higher air movement.

Sabrani and Payne (1977) reported 4.32 per cent and 1.65 per cent weight loss for eggs held at 28°C and 12°C respectively when stored for 18 days.

Quyyam (1980) reported that mean egg weight was found to vary significantly ($P<0.01$) from the producer to the retailer. The egg weight was more at the producer and less at the retailer levels. This observation is in conformity with Mueller (1957) and Trail (1953) who reported that extension in storage or handling is responsible for lowered egg weight besides causing similar reduction in internal egg quality.

Albumen Index.

Heiman and Carver (1936) devised albumen index as a measure of albumen quality. It is the ratio of the mean albumen height in mm to the mean albumen width in mm.

Wilhelm and Heiman (1938) using albumen index and yolk index as criteria of quality found a consistent drop in egg quality from the time the hens came into production until a low point was reached in July ; there then followed a slight increase in quality. The effect of temperature on the

decline of albumen index when held at different temperatures was reported by Jensen and Stadelman (1951). The percentage decline was 23, 25, 30 and 35 for 50°F, 62°F, 68°F and above 68°F when the eggs were stored for a period of seven days. In a study to determine the influence of position of eggs on their interior quality Orel and Musil (1956) found that for the eggs placed small end up the average albumen index was 6 to 7 per cent and for those placed in horizontal position 14.9 per cent lower than the eggs placed with their small end down ($P<0.01$).

A report on the effect of temperature and time on the egg quality by Rhodes and Feeney (1957) showed a decline of albumen index for eggs held at different temperatures and for different periods. The study was conducted on different flocks and variations due to the flock difference was also noticed. For flock B when the eggs were held at 2°C for 48 hours and 44°C for 48 hours the albumen index was 0.074 and 0.075 respectively. For flock C at 2°C for 94 hours and at 44°C for 94 hours the albumen index was 0.072 and 0.024 respectively. For flock D at 44°C for 49 hours and 97 hours, the albumen index was 0.051 and 0.027. For flock E at 44°C, 46 hours and 98 hours of storage gave a value of 0.043 and 0.020.respectively.

Kumar *et al.* (1968) reported percentage drop in albumen index in lime sealed and untreated eggs when stored at room temperature (28°C and 58.5% RH) for different periods. It was 26.7, 45, 50.3 for lime sealed eggs and 68.3, 70.91 and 100 for untreated eggs when held for 14, 21 and 28 days respectively.

Sreenivasulu Reddy *et al.* (1969) gave a graphic representation of the quality deterioration of albumen in terms of albumen index. The drop in albumen index for eggs with no treatment at room temperature (83-84°F and 35-40% RH) was more, lesser for the oil sprayed ones and the least for oil dipped ones. Length of storage increased the decline in all the three treatments.

Variations in albumen index in eggs kept for 20 days at 35°C as affected by different shell treatments were shown by Verma and Sathe (1970). Albumen indices were 0.038, 0.024, 0.016 for those treated with processed coconut oil, commercial egg coating oil and for those eggs kept without any treatment respectively.

Leehuba *et al.* (1971) observed albumen index as 0.0404, 0.0366, 0.0240 and 0.0077 after the eggs were kept for one week at 32°C and 68 per cent relative humidity, two weeks at 36°C and 70 per cent relative humidity, three weeks at 35°C

and 59 per cent relative humidity and 42°C and 66 per cent relative humidity respectively.

A decline of albumen index from 0.064 to 0.012 and from 0.064 to 0.033 was recorded for eggs kept at room temperature (30.5°C and 45.1% RH) and those kept under refrigeration respectively for 15 days (Naidu and Siddiqui, 1971).

Kamdikar et al (1971) in a study reported the effect of storage time on the albumen index when untreated eggs where stored at room temperature (28.4°C and 75% RH) for varying periods. The percentage decline were 73.2, 76.8 and 81.4 for 5, 10 and 15 days of storage respectively.

In a study with clean and dirty eggs, Jairaj et al. (1972) reported decline in albumen index when the eggs were kept for 15 days at room temperature (29.9°C and 42.5% RH). The percentage decline in albumen index was 82.8 and the same for dirty eggs was 87.2.

Nambiar (1975) reported an albumen index decline of 29.4 per cent, 33.8 per cent and 80.9 per cent for oil treated, lime treated and untreated control when the eggs were held at room temperature (80°F) for 14 days.

Yolk Index.

Sharp and Powel (1930) devised yolk index as a measure of egg quality and showed that this quality decreased rapidly under adverse storage conditions. Similar results have been obtained by many workers including Holst and Almquist (1932), Funk (1944) and Gibbons (1950).

A seasonal decline in yolk quality of eggs was reported by Knox and Godfrey (1934). Yolks in eggs stored during fall and winter remained in better condition than those stored in other seasons.

Wilhelm and Heiman (1938) reported a consistent drop in yolk index from the time the hens came into production until a low point was reached in July.

Jackwolk et al. (1951) opined that the effect of time on yolk condition is a linear regression, the slope of the line varying directly with temperature. These workers felt that from such linear regression knowing one of the factors of time and temperature, the other factor can be determined.

Wesley and Stadelman (1957) concluded that Haugh units, yolk index, thin albumen diameter, chalazae size and yolk mottling were the most practical interior quality measurements to fully evaluate quality of broken eggs. They also observed a significant decrease in yolk index when the eggs were held for 24 hours.

Panda et al. (1966a) reported yolk index of eggs held at room temperature of 76°F and 84 per cent relative humidity as 0.327 at 15 days and 0.232 at 30 days. Further, Panda et al. (1968) observed yolk index in market eggs at different seasons of the year as 0.321, 0.371, 0.376, 0.353 for summer, rainy season, spring and winter.

Kumar et al. (1968) reported percentage drop in yolk index for lime treated eggs and for untreated eggs when stored at room temperature (28°C and 38.3% RH). It was 6.81, 17.4 and 29 for lime treated eggs and 51.2, 59.6 and 70.3 for untreated controls for 14, 21 and 28 days of storage respectively.

Yolk index decline of 55.89 per cent for untreated and 6.69 per cent for oil treated eggs were reported by Naidu and Siddiqui (1971) after a storage period of 15 days at 30.5°C and 54.1 per cent relative humidity.

Verma and Sathe (1970) reported yolk index values of eggs held for 20 days at different conditions of storage. The yolk indices were 0.280, 0.218 and 0.108 for those treated with processed coconut oil, those treated with commercial egg coating oil and for those kept without any treatment respectively when held at a temperature of 35°C.

Jairaj et al. (1972) reported a decline of 63.3 per cent when the eggs were held for 15 days at a temperature of 31.9°C and 42.5 per cent relative humidity.

Nambiar (1973) reported a decline of 48.9 per cent at 14 days storage at a room temperature of 80°F and 62.4 per cent relative humidity when the eggs were held for 28 days under the above conditions. Similar figures for lime treated eggs were 16.1 per cent and 16.5 per cent.

In an experiment to determine the effect of egg size, length of storage, storage temperature, albumen pH and albumen viscosity on the vitelline membrane, Heath (1975a) observed that the dry membrane weight decreased as a percentage of dry yolk weight as the egg weight decreased. Vitelline membrane strength increased under refrigeration (7°C) conditions and decreased at room temperature (22°C). The length of storage from 0 to 9 days had no effect at 7°C or 22°C on membrane weight although albumen breakdown occured as evidenced by increased pH.

In another study (Heath, 1975b) it was shown that eggs refrigerated at 10°C for 7 days had less moisture, lower albumen pH and higher yolk index than those held at room temperature of 27.5°C. Preventing gas exchange both at refrigeration and room temperature conditions resulted in a decrease in albumen pH and no change in yolk index over

a seven day storage period. When gas exchange was permitted under these conditions albumen pH increased and yolk index decreased.

Haugh Unit Score.

Haugh unit score, developed by R.R.Haugh (1937) is regarded to be the most dependable measure of egg quality. It is a ratio of the height of dense albumen to the weight of the egg.

Brant et al. (1951) presented a critical review of the majority of the criteria on the measurement of albumen quality. They compared the techniques for reliability, speed and simplicity and came to the conclusion that Haugh units provided the most satisfactory measurement of albumen condition.

Moeller (1957) reported that the Haugh unit of fresh as well as stored eggs were influenced by diet, season and the housing system. The same study showed that the change in Haugh unit for the first 24 hours of storage was significantly greater than for any succeeding daily change for the eggs held at 90°F. This change did not hold good for the temperature range of 30°F and 60°F. However, the change in the Haugh unit for the first 48 hours after the eggs were placed in storage was significantly greater than

the changes for any succeeding 48 hours period. This was true for 30°F, 60°F and 90°F and appeared significant at all the three temperatures ($P<0.01$). Eggs stored at 90°F for one day were lower in quality than those stored at 60°F for seven days. Eggs stored at 60°F for one day was inferior in quality to eggs stored at 30°F for seven days. After an initial loss of three Haugh unit during the first two daysof storage the eggs stored at 30°F maintained approximately the same quality throughout one week.

The relative humidity of the storage area had no economically significant effect on albumen quality as expressed in Haugh unit (Kerslund, et al 1956). However, in another experiment, he observed that high humidity was more beneficial in maintaining albumen quality.

May et al. (1957) reported that initial albumen quality of various strains, as measured by Haugh unit was found to differ at 0.01 per cent level of probability. Differences among strains as to the rapidity of decline of albumen quality were also found to differ at 0.01 per cent level of probability. A correlation coefficient of 0.358 was found between the original albumen quality and the loss of quality over seven days storage period indicating that the eggs of low quality had a lower rate of quality decline than the eggs of initial high quality.

A decline in Haugh unit was observed due to the aging of the hen and this had no effect on the season (Cunningham et al. 1959). Bornstein and Lipstein (1962) found that when internal quality deterioration of eggs held at 32°C for 14 days was measured and plotted in terms of both Haugh unit and yolk index the general trend was approximately parallel for both measures. However, when a similar comparison between these measures was made for eggs held at 15°C, the relative lack of sensitivity of yolk index, was clearly evident. Kumar et al. (1968) reported a Haugh unit drop in lime sealed eggs and untreated control when stored at room temperature (28°C and 58.5% RH) for varying periods. It was 16.5 per cent, 27.06 per cent, 34.11 per cent for lime sealed eggs and 45.88 per cent, 41.18 per cent and watery for untreated controls when held for 14, 21 and 28 days respectively. Sreenivasulu Reddy et al (1969) reported a steep fall in Haugh units after two weeks of storage at room temperature of 84°F and 35 per cent relative humidity.

In a study on market eggs at the Gifu city in Japan, Brant et al. (1969) observed that the Haugh unit reflected the temperature difference for two seasons. Winter eggs averaged 70.5 to 44.9 for spring eggs. Age of flock might also have contributed to this reduction.

Panda et al. (1969) reported a decline of Haugh units for 15 days of storage at room temperature of 27.7°C and

44 per cent relative humidity, when the eggs were first kept in refrigeration temperature and then exposed to room temperature. It was 16.27 per cent for oil treated eggs and 42.93 per cent for lime treated eggs.

Ted Wasylyshen (1970) reported that the Haugh unit drops sharply during the first two days holding at a temperature of 50°F to 75°F and then slowly depending on the temperature. After holding eggs for six days at 50°F the Haugh unit remains steady but at higher temperatures the Haugh unit continues to drop. A drop of 31.48 per cent was reported when the eggs were held for 20 days at an environmental temperature of about 35°C.

A Haugh unit drop of 72.6 per cent and 13.7 per cent at room temperature (30.5°C and 54.1% RH) and refrigeration temperature (5°C) respectively was reported by Naidu and Siddiqui (1971) when the eggs were held for 15 days.

Kandlikar et al (1971) reported a Haugh unit drop of 22.7 per cent, 38.7 per cent and 53.3 per cent for 5, 10 and 15 days of storage of untreated eggs at room temperature of 28.4°C and 75.1 per cent relative humidity.

Loehube et al. (1971) reported a Haugh unit decline of 36.24 per cent at room temperature (74°F and 84% RH) when the eggs were held for three weeks.

Jairaj et al. (1972) reported a percentage decline in Haugh unit when clean eggs were kept at 31.9°C and at a relative humidity of 42.5 per cent for 5, 10 and 15 days as 12, 24 and 44.5 respectively. Corresponding figures for dirty eggs were 47, 55.8 and 67.5.

Effect of air movement on the quality parameters was demonstrated by Maurer (1974). He reported a Haugh unit loss of 3.4 and 3.8 for air movement rate of 5.9 and 9.5 metre per minute when the eggs were held at refrigeration temperature for three weeks. Effect of closed and open carton packing under the above condition had brought about Haugh unit loss of 3 and 4.2 respectively. Effect of time on Haugh unit loss was found to be 3.5 (5.13%) when the eggs were held for three weeks at refrigeration temperature.

Nambiar (1975) reported a decline of about 80.16 per cent for 14 days of storage when the untreated eggs were held at 80°F. Similar values for lime sealed eggs were 25.05 per cent. Sabrani and Payne (1977) reported a Haugh unit decline of 29.55 per cent for eggs held at a temperature of 12°C for 18 days and 48.43 per cent for eggs held at 28°C for the same period.

Percent thick albumen.

It is the per cent thick albumen that decides to a large

extent the albumen quality. This is expressed as the ratio of the weight of thick albumen to the total weight of both the thick and thin albumen.

Knox and Godfrey (1934) observed that the percentage of firm white was lowered by exposure to high air temperature during hours immediately after the egg was laid.

Seasonal variation in the percentage of thick albumen was observed by Panda et al. (1968). In a study on the quality of market eggs the average per cent thick albumen was found to be 39.33 for summer, 46.75 for rainy season, 48.16 for spring and 43.83 for winter.

Kumar et al. (1968) reported a drop in percentage of thick albumen in lime treated eggs and untreated eggs when kept at room temperature of 28°C and 58.5 per cent relative humidity. It was 42.28, 52.76, 59.19 for lime sealed eggs and 46.32, 66.54 and 81.61 for untreated controls when held for 14, 21 and 28 days respectively.

Baker and Vadehra (1969) reported that there was a highly significant difference among the strains as far as per cent thick albumen was concerned. In the same study correlation coefficients for per cent thick and Haugh unit scores were positive and varied from a low (r = 0.333) to a high (r = 0.695).

Panda et al. (1969) reported thick albumen percentages of 57.8, 54.4, 39.5, 37.8 and 38.1 for 0, 1, 2, 3 and 4 months of holding for oil coated eggs kept at 5°C. Corresponding values for lime treated eggs were 57.8, 56.9, 45.6, 46.4 and 41.0 and for untreated controls 57.8, 44.9, 46.4, 45.1 and 39.9. For eggs after refrigeration at 5°C for one month and subsequent storage at room temperature (26.7°C and 44% RH) the percentage of thick albumen for 0, 5, 10 and 15 days were 51, 41.2, 38.9 and 36 respectively for oil treated eggs, 51, 42, 37.4 and 30.3 for lime sealed eggs and 51, 33.9, 10.4 and Nil for untreated controls.

For eggs kept at 5°C for 30 days the per cent thick was 49.5 for oil coated eggs, 50.2 for lime treated eggs and 43.4 for untreated controls.

Hydrogen Ion Concentration.

The normal pH of the white is about 7.6 when the egg is laid and after one day at 20°C the pH will be about 8.5 and over several more days will rise to 9.4. This change will be slower at lower temperatures. The pH is apparently controlled by the buffer system of carbonate and bicarbonate and the ratio and concentrations of these ions are themselves controlled by the partial pressure of the carbon dioxide in the external atmosphere with which the egg white equilibrates through the pores in the egg shell (Brooks and Pace, 1938).

Rhodes et al. (1957) reported increase in pH at different temperature and holding time. It was 8.7, 8.9, 9.0, 9.0 for 4 hours, 48 hours, 94 hours and 97 hours when held at a temperature of 2°C and 9.4, 9.4, 9.6, 9.7, 9.4 and 9.5 for 48 hours, 94 hours, 49 hours, 97 hours, 46 hours and 98 hours when held at 44°C.

Meuller (1957) opined that variation in carbon dioxide loss was not a very important factor with respect to the albumen quality deterioration in untreated eggs.

Albumen pH of 7.9 and 8.5 was reported by Panda et al. (1966)[a] for eggs held at 76°F and 84 per cent relative humidity for 15 days and 30 days respectively.

Fromm and Gammon (1968) observed that an albumen pH of 8.0 to 8.6 is suitable for not affecting the yolk shape and vitelline membrane by inhibiting dissipation of the chalazeferous layer, as associated with high pH with age of the egg.

The diffusion of carbon dioxide from egg through the shell commences a chain of events, causing high pH values, making the thick white to become thin and the yolk to become fragile and readily broken. Eggs with high pH values in the white after aging will perform less satisfactorily in functions demanding foaming and heat coagulation of white proteins as in cake making (Shenstone, 1968).

An observation by Kumar et al. (1968) showed the difference in increase of albumen pH for lime treated eggs and untreated controls held at room temperature (28°C and 58.5% RH) for varying periods. The pH has gone up from an initial values of 8.1 to 8.4, 8.4 and 8.6 in lime sealed eggs and 9.3, 9.3 and 9.3 for untreated control at 14, 21 and 28 days of storage respectively.

Albumen pH is largely independent of albumen height (Munro, 1971). Mayer and Hood (1973) used electron-microscopy to investigate the difference between the thick and the thin albumen at pH 7.4 and pH 9.0. There was no difference between the thick and the thin albumen at either pH. The cooked thin and thick albumen at pH 7.4, were similar and were characterised by numerous large spherical osmophilic structures. The cooked thin and thick albumen at pH 9.0 consisted of condensed particles which were embedded in a filamentous matrix. Thick albumen at pH 9.0 had smaller and more numerous asymmetric particles than the thin albumen. The observed differences were attributed to heat lability of various protein and the protein-protein complexes.

Nambiar (1975) reported pH of eggs without treatment, kept at a temperature of 80°F for 14 days and 28 days as

9.2 and 9.2 respectively. Corresponding figures for lime treated eggs were 8.3 and 8.1.

Effect of age of the hen on the pH of the egg during holding at different temperatures was studied by Sabrani and Payne (1977). Initial pH was 7.62 and 7.37 for young and old layers eggs respectively. The pH increase on storage was also almost equal for eggs from both young and old hens. When eggs were held for 18 days at 12°C the pH was 9.38 and 9.24 for young and old hens respectively and at 28°C the corresponding figures were 9.5 and 9.59. Changes in the albumen quality occured relatively independantly of the changes in albumen pH.

Khan and Rath (1980) reported that pH range from 7.65 to 8.46 of egg albumen maintained best egg quality but when eggs were stored at environmental temperature, there was a gradual increase of pH and decrease in Haugh unit score. They reported a pH of 8.23, 9.25, 9.39 and 9.41 for 0, 5, 10 and 15 days of storage of eggs at room temperature.

Methods of Preservation of Eggs

Preservation of eggs increases the storage period and makes possible a better distribution of eggs throughout the year. The principle involved in the preservation is to delay the physico-chemical deterioration and to prevent

microbial spoilage. This is accomplished either by controlling the environment in which the egg is placed or by treating the egg so that it is less easily affected by external conditions.

Several methods of preservation have been suggested, of which refrigeration and oil treatment are commercially practical. Other methods like water glass method, lime sealing, thermostabilization are also employed to preserve eggs in smaller lots, but it has been reported that lime sealing is practiced on a commercial basis in Holland (Hinton, 1968).

Kumar et al. (1968) have studied the effect of preservation of lime sealing and compared it to the oil coating method of preservation and found it to be less effective than the oil coating but much superior to the untreated controls.

Ted Wasylyshen (1970) in a review, made a casual comparative study on the effect of cooler temperature on the quality of eggs. After seven days of storage at room temperature (70-75°F) and cooler temperature (50-55°F) the percentage of 'A' grade eggs were 62 and 97 respectively giving a difference of 35.

Effect of preservation methods were highlighted in a study by Panda et al. (1969) on the advantages of lime

sealing and oil sealing on weight loss and internal quality of shell eggs during refrigeration and subsequent market periods. There was a 13 per cent weight loss in untreated group of eggs during storage at 5°C for 4 months, whereas the corresponding losses were 1.5 per cent and 3.7 per cent for oil coated and lime sealed groups of eggs respectively. Irrespective of the treatment the weight loss was proportionate to the duration of storage.

Effect of air movement rates on refrigerated egg storage was found to be a factor that affected the quality decline (Maurer, 1974).

Results of a study by Nambiar (1975) indicated that lime sealing was a suitable method of preservation of eggs for India where summer temperature is usually quite high.

Thatte et al. (1981) in a study to compare the efficacy of earthern pot method for storage of eggs during hot weather have compared the effect of lime sealing and refrigerator storage of shell eggs for eight days. They have found that the three methods of storage were equally good in maintaining the Haugh unit score, refrigerator eggs giving a Haugh unit score of 88.2, lime treated ones, 86.6 and those stored in earthern pot method giving a value of 81.7.

MATERIAL AND METHODS

MATERIALS AND METHODS

Four hundred and thirty two, infertile eggs were collected from the All India Co-ordinated Research Project on Poultry for Eggs, Mannuthy, in three batches of 144 eggs each, during the middle of March, April and May 1981. All the eggs collected were from a single strain of Single Combed White Leghorn pullets, 6 to 9 months old. While collecting the eggs, care was taken to avoid large varintions in egg weight. The eggs laid after 8 a.m. only were collected to avoid the possibility of including eggs laid on the previous day. The eggs were collected within two hours of lay.

The eggs were first candled for checks and other abnormalities and only apparantly normal eggs were selected. All the eggs were numbered, weighed and initial weights recorded. Weighing was carried out using a mono pan balance to an accuracy of 0.001 g.

One batch of 144 eggs were randomly divided into three lots of 48 eggs each and alloted to three treatment groups, viz. storage at room temperature (T1) storage in lime water (T2) and storage in cooler temperature of 10 to 13°C (T3). Similar procedure was followed in alloting eggs during all the three months of experimental period.

The eggs of the untreated control group were kept in egg filter flats and held at room temperature. The other lot of 48 eggs were kept in lime water thoughout the period of experiment. The lime water used was prepared by the method suggested by Panda et al. (1969). One kg of quick lime was added to one litre of boiling water and the mixture was allowed to cool down to room temperature. Then 4.5 litres of cold water was added to it. Two hundred and twenty grams of powdered common salt was also added to the solution. The mixture was allowed to settle down overnight and the supernatant fluid removed and strained. The clean fluid was collected and used. The eggs to be lime treated were placed in an earthern ware pot with narrow mouth and the lime water was slowly poured over it till all the eggs were immersed. The mouth of the pot was covered and the whole thing kept at room temperature.

The third lot of 48 eggs were kept in the cooler where the temperature was kept at 10°C to 13°C.

From each treatment groups, eight eggs were randomly selected for quality studies on the first, third, fifth, seventh, tenth and fifteenth day of storage as outlined in experimental design (Table 1).

The ambient temperature and humidity were measured daily and recorded for the whole of the experimental period (Table 2).

The parameters considered to measure the albumen quality were percentage of weight loss, albumen index, yolk index, Haugh unit score, per cent thick albumen and albumen pH.

The broken out quality of eggs was measured on a plane level glass surface and seperation of thin and thick albumen and yolk were done using a squeegee. The albumen and yolk heights were measured using Ame's tripod stand micrometer. Albumen width and yolk diameter were recorded using Vernier Callipers. Haugh units were arrived at by taking direct reading from Ame's tripod stand micrometer adjusting the height of the albumen to the weight of the egg.

The albumen index was calculated using the formula

$$\frac{\text{Mean albumen height in mm.}}{\text{Mean albumen width in mm.}}$$

Yolk index was calculated using the formula

$$\frac{\text{Yolk height in mm.}}{\text{Mean yolk diameter in mm.}}$$

Albumen pH was measured using a pH meter immediately after the other internal quality parameters were studied. Percentage of thick albumen was calculated using the formula

$$\frac{\text{Weight of thick albumen in g} \times 100}{\text{Weight of total albumen in g.}}$$

The study was carried out during the months of March, April and May as these months are generally regarded as summer months when the atmospheric temperature is at its peak in Kerala.

The data collected were compiled and subjected to analysis of variance (Snedecor and Cochran, 1967).

RESULTS

RESULTS

The climatic variables viz. the daily maximum temperature, minimum temperature, mean temperature and relative humidity with their respective standard deviations during the experimental period are presented in Table 2. The mean daily temperature and relative humidity were found to be 31°C ± 0.2820 and 61.3 ± 1.2186 per cent respectively.

Pooled data on all eggs studied during the summer months were analysed (Snedecor and Cochran, 1967) and the results presented in Tables 3 to 15.

The average values of various parameters of egg quality observed in the experiment are presented in Tables 3 to 8.

It is apparant from the results that there was significant changes in quality due to storage periods, due to treatments and due to interaction of periods and treatments.

Weight Loss

Data on weight loss set out in Table 3, showed an increase in weight loss corresponding with theincrease in the storage period irrespective of the treatments. Maximum weight loss occurred during the first 48 hours and the subsequent 48 hour periods demonstrated lesser loss in weight. This trend was the same for all the treatments.

Average per cent shrinkage for 15 days of storage was 7.496 for T1, 2.531 for T2 and 2.830 for T3.

Treatment effect was significant. T2 and T3 were significantly different from T1 while T2 and T3 did not show any significant difference between themselves.

Albumen Index

Data are presented in Table 4. Mean albumen index of eggs studied for different periods of storage under different treatment conditions showed significant differences due to periods as well as due to treatments. Mean albumen index of eggs stored for 15 days at room temperature (T1) was significantly lower than that of eggs under T2 and T3. However, the difference in albumen index of eggs under T2 and T3 was not significant. The per cent loss in albumen index during the period worked out to 81.36, 34.4 and 38.27 for treatments T1, T2 and T3 respectively.

Yolk Index

Data on yolk index of eggs studied are presented in Table 5. There was significant difference in yolk index values of eggs under different treatment groups at different periods of storage. The yolk index of eggs held for 15 days at room temperature (T1) was significantly lower than that

of eggs stored for the same period under T2 and T3. T3 was significantly superior than T2. The mean yolk index values for 15 days of storage under different treatments were 0.1709, 0.3926 and 0.4221 for T1, T2 and T3 respectively. The per cent drop in yolk index for eggs for 15 days of storage was 59.95, 6.65 and 3.21 for T1, T2 and T3 respectively.

Haugh Unit Score

Effect of period of storage and the effect of treatments were significant with regard to Haugh unit score (Table 6). The Haugh unit score decreased as the period of storage increased irrespective of the treatments. For 15 days of storage Haugh unit values for T2 (68.75) and T3 (68.79) were significantly higher than the same for T1 (33.29). Nevertheless, T2 and T3 were not significantly different in respect of this trait. Percentage drop in Haugh unit score for different treatments when the eggs were held for 15 days were 62.42, 21.50 and 19.75 for T1, T2 and T3 respectively.

Per cent Thick Albumen

Effect of storage as per cent thick albumen was significant with a drop in percentage as the storage period increased.

The mean thick albumen percentage of experimental eggs irrespective of the treatment was 57.348 initially. However, the same decreased to 37.225, 41.194 and 46.527 for T1, T2 and T3 respectively at 15 days of storage.

For 15 days of storage T3 was significantly superior to T1 but not so with T2. There was no significant difference between T2 and T1 with regard to maintenance of thick albumen percentage.

Albumen pH

Effect of period of storage was significant irrespective of treatments in respect of albumen pH. Effect of treatments was also significant, with T2 maintaining the lowest pH. T2 was significantly superior to T3 and T1 and both T2 and T3 were significantly superior to T1 in maintaining lower pH.

Percentage increase in pH for different treatments were 13.51, 3.01 and 7.42 for T1, T2 and T3 respectively, T1 registering the highest increase.

TABLES

Table 1. Experimental design.

Month	Treatments	Period and No. of eggs P1	P2	P3	P4	P5	P6	Total eggs studied
March	T1	8	8	8	8	8	8	48
	T2	8	8	8	8	8	8	48
	T3	8	8	8	8	8	8	48
Total		24	24	24	24	24	24	144
April	T1	8	8	8	8	8	8	48
	T2	8	8	8	8	8	8	48
	T3	8	8	8	8	8	8	48
Total		24	24	24	24	24	24	144
May	T1	8	8	8	8	8	8	48
	T2	8	8	8	8	8	8	48
	T3	8	8	8	8	8	8	48
Total		24	24	24	24	24	24	144
Grand Total		72	72	72	72	72	72	432

T1 - Storage at room temperature
T2 - Storage in lime water
T3 - Storage at cooler temperature

P1 - Initial quality
P2 - 3rd day quality
P3 - 5th day quality
P4 - 7th day quality
P5 - 10th day quality
P6 - 15th day quality

Table 2. Maximum, minimum and average temperature and humidity during the experimental period.

Readings	March				April				May			
	Temperature °C			Relative Humidity %	Temperature °C			Relative Humidity %	Temperature °C			Relative Humidity %
	Max	Min	Mean		Max	Min	Mean		Max	Min	Mean	
1	33.3	28.3	30.8	62.0	33.3	28.9	31.1	59.5	33.3	28.9	31.1	61.0
2	33.9	28.9	31.4	61.0	33.3	28.9	31.1	60.5	33.3	28.9	31.1	61.0
3	33.3	28.3	30.8	61.5	33.3	27.8	30.6	60.0	33.3	28.9	31.1	60.0
4	33.9	28.3	31.1	62.0	33.3	28.9	31.1	59.0	32.8	28.9	30.9	58.5
5	33.9	28.3	31.1	62.5	33.3	28.9	31.1	59.0	32.8	28.9	30.9	59.5
6	33.3	28.3	30.8	61.0	33.3	28.9	31.1	59.5	32.8	28.9	30.9	59.5
7	32.8	28.9	30.9	61.5	32.2	27.2	29.7	61.5	32.8	28.9	30.9	59.5
8	33.3	28.9	31.1	66.5	33.3	28.9	31.1	59.5	33.3	28.9	31.1	60.0
9	33.3	28.9	31.1	66.5	33.3	28.3	30.8	61.5	32.8	28.9	31.1	58.5
10	32.9	28.9	31.4	73.0	33.3	28.3	30.8	61.0	32.8	28.9	30.9	59.0
11	33.3	28.9	31.1	61.5	33.9	28.3	31.1	61.5	32.8	28.9	30.9	61.0
12	33.3	28.9	31.1	64.5	33.3	28.3	30.8	59.5	32.8	28.9	30.9	61.0
13	33.9	28.9	31.4	67.5	33.3	28.3	30.8	59.5	32.8	28.9	30.9	61.0
14	33.9	28.9	31.4	58.5	32.8	28.3	30.6	62.0	32.8	30.0	31.4	61.0
15	32.8	28.3	30.6	67.5	33.3	28.3	30.8	60.0	32.8	29.4	32.1	61.0
Mean	33.4	28.7	31.1	63.8	33.2	28.4	30.8	60.3	32.9	29.0	31.1	60.1
S.D.	.3418	.2939	.2462	3.6046	.3419	.4728	.3555	.9960	.2211	.2932	.0359	.9345

Overall mean temperature : 31°C ± 0.2820 Overall mean RH : 61.3 ± 1.2186

Table 3. Effect of treatments and periods of storage on the per cent weight loss of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	--	2.954	4.332	5.752	6.073	7.496	5.321
T2	--	1.549	1.849	2.232	2.387	2.531	2.109
T3	--	2.048	1.909	2.159	2.359	2.830	2.260
Mean	--	2.184	2.697	3.381	3.606	4.286	

C.D. for period effects = 0.6198 C.D. for treatment effects = 0.4383

S.E. = 0.6663

Table 4. Effect of treatments and storage periods on the albumen index of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	0.1159	0.0697	0.0560	0.0445	0.0377	0.0216	0.0576
T2	0.1175	0.1044	0.0998	0.0922	0.0810	0.0770	0.0953
T3	0.1144	0.0953	0.0848	0.0886	0.0786	0.0708	0.0881
Mean	0.1147	0.0898	0.0801	0.0751	0.0658	0.0565	

C.D. for period effects = 0.010 C.D. for treatment effects = 0.0078

S.E. = 0.01159

Table 5. Effect of treatments and storage periods on yolk index of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	0.4267	0.3579	0.3081	0.1843	0.2083	0.1709	0.2760
T2	0.4406	0.4118	0.4159	0.4101	0.3969	0.3926	0.4113
T3	0.4361	0.4123	0.4332	0.4370	0.4307	0.4221	0.4286
Mean	0.4345	0.3940	0.3857	0.3438	0.3453	0.3285	

C.D. for period effects = 0.02315 C.D. for treatment effects = 0.01638

S.E. = 0.0243

Table 6. Effect of treatment and periods of storage on Haugh unit score of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	88.583	69.750	64.792	57.792	51.500	33.292	60.951
T2	87.583	83.750	80.580	79.542	72.250	68.750	78.743
T3	86.083	83.000	81.000	78.417	74.875	68.792	78.694
Mean	87.417	78.833	75.458	71.917	66.208	56.944	

C.D. for period effects = 4.7377 C.D. for treatment effects = 3.3500

S.E. = 4.9792

Table 7. Effect of treatments and periods of storage on per cent thick albumen of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	57.684	47.613	44.613	42.011	40.233	37.225	44.924
T2	57.470	44.709	43.724	42.127	40.914	41.194	45.059
T3	56.891	51.110	49.645	46.561	46.130	46.527	49.477
Mean	57.348	47.866	45.994	43.567	42.434	41.649	

C.D. for period effects = 4.3013 C.D. for treatment effects = 6.6748

S.E. = 9.9208

Table 8. Effect of treatment and periods of storage on the albumen pH of shell eggs during summer.

Treatments	Periods of storage						Mean
	P1	P2	P3	P4	P5	P6	
T1	8.085	9.058	9.235	9.248	9.148	9.177	8.992
T2	8.215	7.968	8.013	7.998	7.981	8.463	8.106
T3	8.090	8.743	8.743	8.831	8.880	8.691	8.662
Mean	8.130	8.589	8.662	8.692	8.675	9.610	

C.D. for period effects = 0.0209 C.D. for treatment effects = 0.0147

S.E. = 0.0218

Table 9. Analysis of variance for weight loss in shell eggs.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	4	191.3280	47.8320	39.86**
Treatment (T)	2	788.1833	394.0900	328.00**
Interaction (P x T)	8	126.1018	15.7628	13.00**
Error	346	415.2794	1.2002	
Total	360	1520.8925		

** Significant (<0.05).

Table 10. Analysis of variance for albumen index.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	5	0.1497	0.0299	78.68**
Treatment (T)	2	0.1156	0.0578	152.11**
Interaction (P x T)	10	0.3082	0.0031	8.11**
Error	414	0.1576	0.0004	
Total	431	0.4537		

** Significant (<0.05).

Table 11. Analysis of variance for yolk index.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	5	0.5735	0.1147	68.4764**
Treatment (T)	2	2.0093	1.0047	599.7910**
Interaction (P x T)	10	0.7798		46.5540**
Error	414	0.6933	0.0017	
Total	431	4.0558		

** Significant (<0.05).

Table 12. Analysis of variance for Haugh unit score.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	5	46489.97	9297.99	132.62**
Treatment (T)	2	36997.79	18498.90	263.85**
Interaction (P x T)	10	5362.15	536.22	7.64**
Error	414	29026.50	70.11	
Total	431	117876.41		

** Significant (<0.05).

Table 13. Analysis of variance for per cent thick albumen.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	5	12129.94	2425.99	8.72**
Treatment (T)	2	1951.38	975.79	3.51**
Interaction (P x T)	10	910.67	91.07	0.33 N.S
Error	414	115231.71	278.34	
Total	431	130223.90		

** Significant (<0.05). N.S. Not Significant.

Table 14. Analysis of variance for albumen pH.

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Period (P)	5	0.8256×10^{-14}	0.1651×10^{-14}	122.30**
Treatment (T)	2	1.2105×10^{-14}	0.6005×10^{-14}	444.81**
Interaction (P x T)	10	1.4316×10^{-14}	0.1431×10^{-14}	106.04**
Error	414	0.5611×10^{-14}	0.0014	
Total	431	4.3619×10^{-14}		

** Significant (<0.05).

Table 15. Quality deterioration of shell eggs under different treatments for 15 days of storage.

Egg quality parameters	TREATMENTS		
	Eggs stored at room temperature T1	Eggs stored under lime treatment T2	Eggs stored at cooler temperature T3
Weight loss	7.4960 b	2.5310 a	2.8300 a
Albumen index	0.0216 b	0.7700 a	0.7080 a
Yolk index	0.1709 c	0.3926 b	0.4221 a
Haugh unit score	33.2917 b	68.7500 a	68.7917 a
Per cent thick albumen	37.2250 b	41.1940 b	46.5270 a
pH	9.1770 a	8.4630 b	8.6910 c

Values bearing same super scripts are not significantly different.

DISCUSSION

DISCUSSION

Weight Loss

Data on weight loss of eggs studied during summer under different treatment conditions revealed that for eggs held at room temperature weight loss was appreciably greater than for eggs held under cooler temperature and under lime treatment. In fact, shrinkage in these two treatments was much less and comparable. Irrespective of the treatments, weight loss of eggs recorded for the first forty eight hours of storage was greater than the same in the subsequent forty eight hour periods. This trend agrees with the report of Dunn (1923) who postulated that the rate of loss in weight of shell eggs appeared to decrease slightly with the time the eggs are held. After fifteen days of storage, the eggs stored under room temperature lost 7.496 per cent weight while the experimental eggs under treatments (T2 and T3) showed a percentage decrease in weight of only 2.531 (lime sealing) and 2.830 (cooler temperature). At room temperature the weight loss was 5.752 per cent even on the seventh day, the same being 6.073 per cent on the tenth day of storage. These findings are comparable with the findings of Jairaj et al. (1972) who observed a weight loss of 4.40 per cent and 7.31 per cent for ten days and fifteen days respectively when clean eggs were held at room

temperature of 31.9°C and relative humidity of 42.5 per cent. Corresponding values for dirty eggs were 5.42 and 8.39 per cent respectively. Naidu and Siddiqui (1971) reported a weight loss of 5.88 per cent and 1.52 per cent for eggs held for 15 days at room temperature (30.5°C and 54.1% RH) and refrigerator temperature respectively. Lochuba *et al.* (1971) recorded a weight loss of 6.69 per cent when the eggs were held for three weeks at 32°C and 68 per cent relative humidity, whereas Verma and Sathe (1970) observed a weight loss of 12.6 per cent for eggs kept at room temperature of 35°C for 20 days.

Code of practice for cold storage of shell eggs prescribed by Indian Standard Institution has stipulated that the eggs meant for storage of about one month at farm level and at egg packing stations shall be stored at a temperature of 10 to 13°C and relative humidity of 75 to 80 per cent (Anon, 1972). They also suggested that the eggs meant for cold storage shall be treated before storage by suitable oil. For the assessment of quality of eggs stored in cold storage the stipulation is that loss in egg weight should not be more than two per cent. The weight loss of 2.830 per cent for cooler held eggs observed in the present study seems to be within limits considering the fact that the eggs were not oil treated before cold storage.

It is a wellknown fact that weight loss is a major physical change that occur in the egg as it ages and is dependant on the porosity of the shell and the environmental conditions existing out side the shell. Therefore, varying reports in respect of weight loss made by different workers can be due to the variations in the experimental conditions, as the same vary from place to place and at different times of the year. Since all eggs studied in the present experiment came from the same flock of birds the porosity of the shell due to strain variations can be ruled out but individual variations and the placement of individual eggs in the clutch should be considered. Tyler (1945) found that the first egg of a clutch tends to have lower porosity than the other eggs in the same clutch. Smith (1932) considering the variation in porosity of eggs gave the probability that eight eggs in every hundred would have weight losses 30 per cent greater or smaller than the mean values. Above all, the experimental conditions have directly influenced this important change. Results of the study clearly indicated that preservation of shell eggs by lime treatment and cooler holding for short duration upto 15 days was quite effective in keeping the weight loss at a minimum. Both the methods of preservation tried in this study were more or less equally effective in minimising weight loss in shell eggs during summer months.

Weight loss in market eggs may be regarded as a serious handicap especially when the eggs are marketed by weight rather than by number. In such situations the result of the present investigations indicate that shell eggs without treatment should not be held more during summer months for economic marketing.

Weight loss of 2.830 per cent for shell eggs kept at cooler temperature observed in the study was significantly lesser than the values obtained for eggs stored at room temperature for 15 days. This agrees with the observations of Meuller (1967) who reported that lower temperature maintained egg weight with less loss than did with higher temperatures. Similarly Sabrani and Payne (1977) reported a weight loss of 1.65 per cent and 4.86 per cent for eggs stored for 18 days at 12°C and 28°C respectively.

Weight loss of 2.67 per cent observed by Nambiar (1975) for lime treated eggs held for 14 days is in agreement with the corresponding results obtained in the present study. Kumar et al. (1968) reported lesser weight losses of 1.4 per cent and 1.915 per cent for lime treated eggs kept at room temperature (28°C and 58.5% RH) for 14 days and 21 days respectively.

In the present study it was observed that lime treated eggs and eggs kept at cooler temperature for 15 days maintained

better weight than those eggs held at room temperature for three days.

Advantage of lime sealing and cooler temperature storage in maintaining lower weight losses in shell eggs reported by the earlier workers have been well substantiated by the results of the study. Nevertheless both the preservation methods employed were found to be equally effective in achieving this objective.

Albumen Index

Albumen index dropped as the storage period increased irrespective of the treatments. This finding is in conformity with the observations of Sreenivasulu Reddy et al. (1969) who found that the length of storage increased the decline in albumen index irrespective of treatments. Albumen index loss in shell eggs in the present study was 81.36 per cent, 34.47 per cent and 38.27 per cent for eggs held at room temperature, under lime treatment and for eggs kept at cooler temperature respectively when the eggs were held for 15 days. The loss in albumen index obtained in the study for untreated eggs kept at room temperature was in agreement with the observations of Kandlikar et al. (1971) who reported an albumen index loss of 81.42 per cent for untreated eggs held at room temperature (28.4°C and 75.1% RH) for 15 days. An albumen index loss of 82.7 per cent for 15 days of

storage was observed by Jairaj et al. (1972) for untreated eggs held at room temperature (31.9°C and 42.5% RH). Naidu and Siddiqui (1971) found a drop in albumen index for untreated shell eggs kept at room temperature (30.5°C and 54.1% RH) and for refrigerated eggs when held for 15 days amounting to 81.25 per cent and 48.44 per cent respectively. These values also are in agreement with the values of the present work. Comparable albumen index drops of 81.15 per cent and 29.13 per cent for untreated eggs kept at room temperature (85°F) and for eggs kept under lime treatment respectively for 15 days of storage was reported by Nambiar (1975).

Important observation made in the present work was that eggs held for 15 days under lime treatment or cooler temperature was superior to untreated eggs held for three days under room temperature with respect to this parameter.

Result of the study indicated that both lime treatment and cooler holding of shell eggs are beneficial in maintaining the albumen index at reasonable levels with minimum drop during summer. Both the treatments, viz. lime sealing and cooler holding are equally effective in maintaining egg quality with regard to albumen index. Lime treatment brought about lesser drop in albumen index than holding eggs at cooler temperature. However, the difference between these two preservation methods was not significant.

Yolk Index

The linear drop in yolk index corresponding with the period of storage observed in this study is in agreement with the earlier observations of Jack Wolk et al. (1951) who opined that the effect of time on yolk condition is a linear regression ; the slope of the line varying directly with the temperature. The present study indicated a yolk index decline of 59.95, 6.5 and 3.21 per cent for 15 days of holding for eggs held at room temperature, eggs held under lime treatment and for eggs held at cooler temperature (10-13°C) respectively suggesting that both the treatments were significantly superior to untreated controls in keeping yolk quality at reasonable levels. Of the two treatments holding eggs at low temperature (10-13°C) was significantly better than the lime treatment in maintaining the standing up quality of yolk.

Kumar et al. (1968) observed a drop in yolk index when the eggs were held for 14 days, the same being 51.2 per cent and 6.8 per cent for eggs stored at room temperature (28°C and 58.5% RH) and for eggs lime treated and kept at the same temperature respectively.

Jairaj et al. (1972) reported a decline in yolk index of 63.3 per cent for eggs kept for 15 days under room temperature of 31°C and 42.5 per cent relative humidity

whereas Nambiar (1975) reported a decline of 48.9 per cent for eggs held for 14 days at 80°F. He further reported a decline in yolk index of 16.1 per cent and 16.5 per cent for lime treated eggs for 14 days and 28 days respectively.

Heath (1975b) reported higher yolk index for regrigerated eggs at 10°C for seven days than those held at room temperature of 27.5°C for the same period.

The variations in the values obtained in the present study to the earlier observed values might be due to the slightly different experimental conditions that existed.

The better maintenance of yolk index in lime treated eggs can be attributed to the minimising of gas exchange through the shell caused by the thin coating of calcium carbonate and consequent lower level of pH values. Infact, the standing up quality of yolk is maintained by the thick albumen. Maintenance of higher yolk index in cooler held eggs might be due to the above reason, inaddition to the effect of lower temperature which prevents the weakening of the vitelline membrane. Heath (1975a) observed that vitelline membrane strength increased under refrigeration (7°C) conditions and decreased under room temperature (22°C).

Haugh Unit Score

Effect of period of storage was evident; the Haugh unit score decreasing as the period of storage increased.

Effect of treatment on Haugh unit score was also significant. Both the preservation methods were significantly superior to untreated controls in maintaining higher Haugh unit values. But the difference between the two treatments was not statistically significant.

Percentage decline in Haugh unit score obtained in the study was comparable to the corresponding values obtained by earlier workers, taking into account the variations in experimental conditions.

A decline in Haugh unit score of 42.93 per cent was observed by Panda *et al.* (1969) for 15 days of storage for pre-refrigerated eggs at room temperature of 27.7°C and 44 per cent relative humidity.

Naidu and Siddiqui (1971) reported 72.6 per cent and 13.7 per cent Haugh unit decline for eggs held for 15 days at room temperature (30.5°C and 54.1% RH) and for eggs kept under refrigeration (5°C) respectively.

Haugh unit decline of 12 per cent, 24 per cent and 44.5 per cent for 5, 10 and 15 days respectively for clean eggs held at room temperature (31.9°C and 42.5% RH) and

47 per cent, 55.8 per cent and 67.5 per cent for dirty eggs kept under the same conditions was reported by Jairaj *et al*. (1972).

Nambiar (1975) reported a percentage decline in Haugh unit of 80.16 for 14 days when the eggs were held at 80°F. Corresponding value for lime treated eggs was 25.05 per cent.

Sabrani and Payne (1977) reported a Haugh unit decline of 29.55 per cent for eggs held at 12°C for 18 days and 48.43 per cent for eggs held at 28°C for the same period.

Indian Standard for quality of shell eggs do not specify Haugh unit values for different grades. However, Haugh unit score is regarded as the most dependable measure of egg quality. Considering US standards based on Haugh unit score, untreated control eggs maintained 'A' quality only for 48 hours while the lime treated and cooler eggs maintained the same quality for seven days and five days respectively.

The results of the present investigation demonstrated that lime treatment and cooler holding of shell eggs are good preservation methods in maintaining egg quality in terms of Haugh unit for short periods in summer months.

Per cent Thick Albumen

As for other egg quality traits, the effect of period

was evident with a decrease in per cent thick albumen corresponding with the increase in the period of storage. Holding eggs at lower temperature was decidedly superior to both lime sealing as well as room temperature storage in maintaining the per cent thick albumen. Lime sealing also appeared better than the untreated eggs in maintaining this quality. But the difference between the two was not statistically significant. Kumar et al. (1968) reported per cent thick albumen decline for lime treated eggs and untreated controls held at 28°C and relative humidity of 58.5 per cent as 38.6 per cent and 46.32 per cent respectively. Panda et al. (1969) found that there was not much difference between lime treated and untreated eggs in maintaining the per cent thick albumen when the eggs were kept at 5°C for four months. Decline in per cent thick albumen for lime sealed eggs was 29 per cent and for untreated control 30 per cent.

The decline in per cent thick albumen for 15 days of storage observed in the present study was 35.47 per cent for eggs held at room temperature, 28.69 per cent for lime treated eggs and 18.22 per cent for eggs held in cooler.

The result indicated that holding of eggs at low temperature is most beneficial for maintenance of per cent thick albumen satisfactorily.

Hydrogen Ion Concentration

Lime treatment was found to have a significantly superior effect than holding the eggs at cooler temperature and at room temperature as far as albumen pH was concerned.

Percentage increase in pH for different treatments were 13.51, 3.01 and 7.2 for T1, T2 and T3 respectively; T1 registered the highest increase.

Eggs under both preservation methods held for 15 days had lower pH than the eggs held at room temperature for three days suggesting that the preservation techniques employed are acceptable methods of storage in view of the desirable pH. In the present study when the eggs were held for a period of 15 days the pH of albumen was 9.177, 8.463 and 8.891 for control, lime treated eggs and cooler held eggs respectively. This is in conformity with the observations made by Nambiar (1975) who reported a pH of 9.2 for eggs held for both 14 days and 28 days at room temperature (85°F) and 8.3 and 8.1 for lime treated eggs for 14 days and 28 days respectively. Sabrani and Payne (1977) reported albumen pH of 9.38 for eggs held for 18 days at 12°C. At 28°C the corresponding figure was 9.5.

Eggs held under the two preservation methods for 15 days in the present study maintained lower pH than the eggs held for 3 days at room temperature without any shell treatment.

Results of the study demonstrated that holding eggs at room temperature (31°C) during summer months adversely affected all the quality factors greatly, the detrimental effect being greater with length of holding period. Infact even on the third day of holding these eggs were inferior with regard to all the quality traits compared to the eggs subjectedto storage under lime treatment and at cooler temperature (10-13°C). It is true that even on the 15 th day of storage the eggs at room temperature did not show 'addling' inspite of appreciable decline in quality. However, the stress in handling and transportation in marketing channels has to be considered while advocating optimum period for holding shell eggs during summer. From the 10th to 15th day of storage the decline appeared rather sharp. The Haugh unit value of eggs on the 10th day was 51.5 which turned out to 33.29 on the 15th day. This trend is evident with other quality traits as well. The overall quality decline suggested that eggs should not be held over 10 days at room temperature during summer months before reaching the ultimate consumer.

However, quality of eggs under both the treatments in the study was maintained satisfactorily upto 15 days of storage and therefore the methods employed appeared suitable for keeping smaller lots of eggs for shorter periods in

summer. Infact, the quality of eggs under both the treatments at 15 days of storage was comparable to untreated eggs kept at room temperature for two days. Lime sealing and holding eggs at 10-13°C were found to be almost equally effective in minimising quality decline of shell eggs stored for 15 days during summer. Of the two methods of preservation employed, lime sealing appeared better with regard to maintaining better albumen index and albumen pH, while holding eggs at lower temperature (10-13°C) was decidedly superior in minimising the thinning of thick albumen and maintaining yolk index.

Even though, both the preservation techniques are found to be almost equally beneficial, the practical utility of these has to be considered. For small scale farmers, whose daily collection is in small lots, lime sealing is economical and easily adaptable. The high cost of refrigeration is also a handicap where small lots of eggs are handled. Therefore, lime sealing can be safely recommended to small scale egg farmers for holding of their product for shorter periods during summer, for economic marketing.

SUMMARY

SUMMARY

A study was undertaken to evaluate the extent of decline in quality of shell eggs during summer, during 15 days of storage at room temperature without any treatment and in lime treated eggs and eggs stored in an egg cooler at 10-13°C for the same period.

In all, 432 shell eggs were used for the study. One hundred and forty four eggs each were subjected to the experiment during the three months of March, April and May, 1981. The average temperature and humidity conditions prevailed during the period of study was 31°C and 61.3 per cent relative humidity, respectively. Of the 144 eggs studied during each month, 48 eggs each were alloted to the three experimental groups. Out of the 48 eggs in each group, eight eggs were utilized for initial quality assessment and of the rest 40 eggs, eight eggs each were evaluated on the 3rd, 5th, 7th, 10th and 15th days of storage. The factors of quality estimated were weight loss, albumen index, yolk index, Haugh unit score, Per cent thick albumen and pH.

Results of the study revealed the following:

1. Quality declined corresponding to the length of storage period irrespective of the treatments.

2. Decline in quality during the first 48 hours was proportionately greater than that during subsequent 48 hour periods in all the treatment groups.

3. Comparatively faster decrease in all egg quality factors was observed in untreated control eggs than among treated ones.

4. At 10 days of storage, untreated control eggs exhibited a Haugh unit value of 51.5 while at 15 days of storage, this score further declined to 33.29. Similarly, all other quality factors had greatly decreased at 15 days, eventhough 'addling' was not observed. However, at 10 days of storage untreated eggs underwent fair degree of deterioration but were still marketable.

5. Decline in quality among treated eggs was rather gradual, and even on the 15 th day of storage, eggs under both lime treatment and cooler holding demonstrated satisfactory market quality in terms of major quality factors. Both the methods of preservation employed appeared equally beneficial. Of the two, lime sealing appeared superior in maintaining better yolk index and lesser albumen pH, while, holding at lower temperature seemed advantageous in minimising the thinning of thick albumen.

6. It was concluded that shell eggs without any treatment could be held at room temperature for 10 days during summer months.

7. Both lime sealing and holding at low temperature of 10-13°C are greatly beneficial. Eggs could be held for 15 days under these conditions without marked deterioration in quality.

8. Being an inexpensive and simpler method, lime sealing appears more suitable for small scale egg farmers whose production is in small lots.

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KEEPING QUALITY OF SHELL EGGS DURING SUMMER

BY

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ABSTRACT OF A THESIS

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ABSTRACT

A study was conducted to asses the keeping quality of shell eggs during summer months of March, April and May. Quality deterioration on 3rd, 5th, 7th, 10th and 15th days of storage of eggs held at room temperature was measured. Simultaneously lime treated eggs held at room temperature and eggs held in cooler at 10 to 13°C were also evaluated similarly. A total of 432 tables eggs were used for the study, 144 eggs under each treatment. The traits measured for quality assessment were weight loss, albumen index, yolk index, Haugh unit score, per cent thick albumen and albumen pH.

The following observations were made from the study:

1. The average temperature and humidity during the three months of study did not vary greatly and were 31°C and 61.3 per cent relative humidity respectively.

2. Irrespective of the mode of storage deterioration in quality with respect to all the traits increased with the increase in the period of storage.

3. Based on Haugh unit score it was observed that eggs stored at room temperature without any treatment maintained reasonable quality only upto ten days while those stored under both the treatments were reasonably good even on the

15th day of storage.

4. At all stages of storage upto 15 days eggs held at room temperature without any treatment were decidedly inferior to those stored in cooler or after lime treatment, with regard to all quality factors.

5. Both lime treatment and holding in cooler were found equally effective in maintaining egg quality upto 15 days of storage.

The following conclusions were drawn based on the results of the study.

i. It is not advisable to keep shell eggs at room temperature in summer for more than ten days before consumption.

ii. Eggs can be stored safely for 15 days without loosing market quality greatly if preserved after lime treatment or in cooler at 10 to 13°C.

iii. Eventhough both the methods of preservation employed in the study were found to be more or less equally effective, lime sealing appeared a simple economic and suitable technique of preservation for small scale producers.