Pakistan J. Sci. Ind. Res., Vol. 22, No. 6, December 1979

PRESERVATION OF SHELL EGGS WITH DIFFERENT COATING AGENTS

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(Received March 26, 1979)

White leghorn eggs were treated with different levels of chlorinated wax emulsion, liquid paraffin and carboxymethyl cellulose. After incubation at 35^{O} for 6 weeks the loss in weight of eggs was least for eggs treated with 6 and 9% wax emulsion than nontreated and eggs treated with carboxymethyl cellulose and liquid paraffin. The air cell size, yolk and white indices as well as flavour characteristics of eggs treated with 6 and 9% levles showed the good retention of quality as compared with control eggs even after storage for 42 days at 35^{O}. The eggs treated with liquid paraffin and carboxymethyl cellulose deteriorated much earlier than with the eggs treated with 6 and 9% wax emulsion. This shows the superiority of wax emulsion over all other treatments tried for the preservation of the shell eggs.

INTRODUCTION

Egg production has increased considerably due to rapid development of poultry industry in the country. There is definite need to develop suitable methods for the preservation of eggs. The eggs are a perishable commodity and a considerable proportion of eggs produced in the country are wasted due to the deteriorative changes which are accelerated by the high temperature in summer. The supply of eggs can be made regular round the year either by enhancing the shelf-life of eggs by proper treatments and storage or by preservation and storage of egg products, e.g. after breaking open the eggs and preservation by freeze-drying and dehydration of the pulp. The methods which are economically feasible and whereby shell eggs are preserved on a commercial scale would find great application in Pakistan. Eggs so preserved can be safely exported and sent long distnaces or supplied to the market according to demand.

Under commercial practice eggs can be stored at 29–32^{O}F for periods up to nine months during which they will remain in a state not grossly dissimilar from fresh eggs [1]. The other short term methods such as coating and oiling of the eggs may also be used for preserving eggs. Ivan *et al.* [2] reported a coating agent which consists of a mixture of paraffin and other petroleum products with addition of stabilizer and fungicide. Other coating agents such as polymers [3], acrylic acid resins, polyvinyl alcohol and zein [4–5]; sodium carboxymethyl cellulose [6] and spray coating with petroleum white oil [7] have also been reported in literature. These coating agents effectively check loss of water and CO_2 from eggs and prevent degradation of egg proteins.

Present investigation were undertaken with the object to develop suitable coating agents which when applied to eggs can preserve them for longer periods even under ordinary storage conditions.

MATERIALS AND METHODS

Formulation and Development of Coating Agents. (i) The chlorinated wax emulsion was prepared from paraffin wax [8]. This stock emulsion was further diluted for treatment at three concentration levels, i.e. 3, 6 and 9%. (2) Sodium Carboxymethyl Cellulose (CMC): 6% solution of CMC was prepared. To this was added 0.2% mixture of methyl and propyl paraben in the ratio of 7:3. This mixture was stirred thoroughly for 5 min. (3) Liquid Paraffin: 1% solution of sorbitone monooleate was added to liquid paraffin and stirred thoroughly for 5 min.

Eggs Collection. Poultry farm with good sanitary conditions was selected for the collection of fresh eggs which were laid within 24 hr.

Groupings and Treatments. 48 eggs from similar genetic and nutritional background and with sound shells were allocated in each group. Each group was further subdivided at random into 8 subgroups, consisting of 6 eggs each.

Eggs of each group were treated as follows: (1) control – no treatment, (2) 3% wax emulsion, (3) 6% wax emulsion, (4) 9% wax emulsion, (5) C.M.C., and (6) liquid paraffin.

The treatments were carried out for each group of eggs in a bucket. The eggs were weighed and dipped in each solution/emulsion for 2 min. After that eggs were taken out and dried under a ceiling fan for 3 hr. The eggs were then again weighed and placed in egg containers and stored in an incubator which was maintained at 35 ± 1^{O} for accelerated studies.

One subgroup from each group containing 6 eggs was examined weekly for quality standards.

Quality Standards. The quality characteristics which were determined were as follows. (i) Air Cell Size: This was determined by the conventional candelling technique [8] (ii) Egg Weight Loss: The eggs were weighed initially and after every week and the percentage loss of weight was calculated. (iii) Egg Yolk and White Indices: A spherometer was used for measuring the heights of yolk and thick whites. The scale was placed under a glass sheet which was fixed on a table and was levelled with a water leveller. The eggs were carefully broken on this flat glass sheet and the mean widths of yolk and thick white were recorded. The height of yolk and thick white were also recorded. The yolk and thick white which are the ratios of their heights to their mean width were calculated [10–11].

Subjective Evaluation. The eggs were broken on a flat glass sheet and the condition of thick white whether regular or irregular was recorded subjectively. The condition of yolk whether flat or standing upright was also noted. The odour of the eggs whether normal or off was also recorded.

RESULTS AND DISCUSSION

Weight Loss. Table 1 shows the percentage loss of weight of eggs for different treatment groups at 35° storage temperature. It is evident from the Table that the loss of weight of eggs is maximum for the control group compared with the other treatment groups. This is due to the fact that there are several thousand minute pores in the shell of the eggs. The water from within the eggs is evaporated through these minute pores which results in the loss of weight of eggs. If eggs are to be stored for long periods it is necessary to hinder the evaporation of water either by controlling the humidity of the atmosphere or by sealing the shell pores with the coating agents.

It is seen from the Table that after 7 days of storage the percentage loss was 5.73 for control, 3.52% for 3% wax emulsion, 1.4% for 6% wax emulsion. 0.82% for 9% wax emulsion, 2.73% for liquid paraffin and 5.74% for sodium carboxymethyl cellulose. The loss for further storage period is minimum for 9% wax emulsion used for coating the eggs. This indicates that 9% wax emulsion is better for sealing the shell pores and thus prevents the loss of weight of eggs. There is however, a need for trying the higher concentration level of wax emulsion for sealing the pores completely.

The different porosities of individual eggs pay a little part in the total weight loss by large batch of eggs, and measurement of such weight losses made at different times and pleces are often in close agreement [1]. The mean loss of weight for 30 days from large randomized samples kept at 30°F and a relative humidity of 80% was approximately 0.9% [1]. The present study was carried out by storing eggs in an incubator at 35°. The mean values shown in Table 1 indicate that the loss of control group after 7-day storage period was 5.73% this value increased further to 11.13% when the eggs were completely spoiled and yolk and white were found mixed up when the eggs were broken. The mean values for 9% wax-treated eggs showed a loss of 1.16% even after storage period of 42 days at 35°. This clearly shows that 9% wax emulsion hinders the evaporation of water by sealing the shell pores.

Air Cell Size (Candeling). The depth of the air cell is a rough indication of the age of the egg and, therefore, there is often a relation between the depth and the internal quality.This is only a rough indiction and not always accurate, however, (i) since a newly laid egg may be of low internal quality and (ii) eggs stored at high temperature and under an atmosphere of high humidity may not have lost much water but may have deteriorated considerably, otherwise. It is, therefore, essential that the depth of air-cell

Table 1. Effects of coating agents on the total loss of weight of eggs stored at 35°.

Condition of storage temp. 35 ± 1° (day)	Control mean (%)	Wax emulsion of different concn level			Liquid paraffin mean (%)	Sodium carboxy-methyl cellulose mean (%)
		3% mean (%)	6% mean (%)	9% mean (%)		
0	–	–	–	–	–	–
7	5.73	3.52	1.4	0.82	2.73	5.4
14	11.13	4.38	2.09	0.82	3.29	8.5
21	16.53	6.38	2.09	0.82	3.29	11.0
28	–	–	2.09	0.82	3.29	13.4
35	–	–	2.64	0.82	3.29	13.4
42	–	–	5.19	1.18	3.28	13.4

Table 2. Effect of coating agents on air space of eggs stored at 35°.

Storage conditions temp. 45° (day)	Control Mean + S.E. (cm)	Was emulsion at different concn levels 3% Mean + S.E. (cm)	6% Mean S.E. (cm)	9% Mean S.E. (cm)	Liquid paraffin Mean S.E. (cm)	Sodium car-boxymethyl Mean S.E. (cm)
0	0.675 ± 0.038					
7	2.92 ± .014	2.03 ±.099	1.70 ± .112	1.50 ± .044	0.8 ± .052	2.2 ± .060
24	3.55	2.28 ±.092	1.80 ± .038	1.60 ± .068	1.2 ± .088	2.70 ± .040
21	–	2.90 ±.131	1.85 ± .088	1.70 ± .044	1.3 ± .084	3.16 ± .027
28	–	3.30 ±.107	1.90 ± .047	1.75 ± .030	2.0 ± .047	3.90 ± .044
35	–	– ± –	1.90 ± .066	1.80 ± .091	3.6 ± .071	– –
42	–	– –	1.93 ± .023	1.90 ± .070	– –	– –

Table 3. Effect of coating agents on yolk indices of eggs stored at 35°.

Storage conditions temp 35°	Control (day)	Wax emulsion of different concn levels 3% Mean S.E.	6% Mean S.E.	9% Mean S.E.	Liquid paraffin	Sodium car-boxymethyl cellulose
0	0.425 ± 0.001					
7	0.260 ± 0.014	0.30 ± 0.0025	0.34 ± .016	0.34 ± 0.012	0.39 ± 0.003	0.34 ± 0.015
14	–	0.24 ± 0.0025	0.30 ± .009	0.29 ± 0.012	0.28 ± 0.0075	0.25 ± 0.007
21	–	–	0.26 ± 0.017	0.27 ± 0.012	0.27 ± 0.012	0.17 ± 0.007
28	–	–	0.25 ± 0.007	0.26 ± 0.025	0.24 ± 0.015	–
35	–	–	0.23 ± 0.003	0.24 ± 0.01	0.222 ± 0.002	–
42	–	–	0.20 ± 0.009	0.21 ± 0.012	–	–

is taken into account and other quality traits should also be given equal weight.

For the first quality of eggs the depth of air cell should not exceed 0.625 cm [9]. It is apparent from the Table 2 that the control eggs without any treatment have an average of 0.675 cm air space. This indicates that the eggs were of good internal quality, as the eggs were laid within 24 hr and quite less air space. After storage of eggs at 35°, in the control group the air space increased from 0.675 to 2.92 cm after 7 days and 3.55 cm after 14 days. This clearly shows the deterioration of quality of eggs as is also apparent from the loss of weight of eggs (Table 1) and decrease in the yolk and white indices (Tables 3, 4).

In wax-emulsion treatment group at 3% level the size of air cells increased from 0.675 to 3.3 cm after 28 days of storage, while at 6 and 9% the levels increase was 1.93 and 1.90 cm respectively after 42 days of storage. These results indicate that the wax concentration at the levels of 6 and 9% was better because there was less loss in weight (Table Table 1) and the increase in air cell size was minimum. The liquid paraffin and sodium carboxymethyl cellulose-treated eggs also showed considerable increase in the air cell size as the storage time was further increased at 35°. These results indicate that wax emulsion at 9% level is better than all other treatments tried as there is considerable reduction in the rate of evaporation during storage at 35° for 42 days.

Yolk Indices. Yolk index is a good criteria for ascertaining the quality of yolk. It is apparent from the results of yolk indices of various treatment groups during storage at 35° that the yolk index of control group is decreased from 0.425 to 0.260 after 7 days (Table 3). After 14 days when the eggs were broken yolk was found to be mixed up with the thick and thin white. This is due to the gradual passage of water from white into the yolk. The rate of absorption of water by the yolk was increased as the storage temperature was increased [12]. The final result of this absorption of water is the weakening and break up of the vitelline membrane and thus yolk becomes flabby and gets mixed up with the egg white.

The mean values of the yolk indices before going into storage was 0.425; the corresponding values after 42 days of storage at 35° were 0.2 and 0.21 for wax emulsions at 6 and 9% levels respectively. The yolk for 9% wax emulsion was still intact after 42 days of storage at 35°. It is expec-

Table 4. Effect of coating agents on white indices of eggs stored at 35°.

Storage conditions temp 35° ± 1° (day)	Control Mean S.E.	Wax emulsion at different concn levels 3% Mean S.E.	6% Mean S.E.	9% Mean S.E.	Liquid paraffin	Sodium carboxymethyl cellulose Mean S.E.
0	.041 ± 0.0001					
7	–	.035 ± 0.0001	.032 ± 0.006	.033 ±0.002	.04 ± 0.008	.05 ± 0.003
14	–	.023 ± .0008	.028 ± 0.001	.037 ±0.001	.039 ± 0.004	.038 ± 0.001
21	–	–	.027 ± 0.017	.03 ±0.005	.039 ± 0.0027	.025 ± 0.005
28	–	–	.026 ± 0.001	.029 ±0.001	.031 ± 0.08	–
35	–	–	.025 ± 0.001	.028 ±0.001	.0285 ± –	–
42	–	–	.024 ± 0.007	.025 ±0.007	–	–

ted that at lower storage temperatures than 35° the period of storage can be further increased without little effect on quality. This aspect however certainly needs detailed investigations.

White Indices. The white index of an egg thick white gives an indication of the condition of the thick white. Table 4 shows the results of white indices. In control group the thick white became irregular and it was not possible to measure its height and width even after 7 days of storage at 35°. The treatment of eggs with wax emulsion at 6 and 9% levels showed significant improvement as compared with the control. The yolk was still surrounded by a good amount of thick white even after 42 days of storage at 35° for treatment groups of 6 and 9% wax emulsion. Although the white indices showed a decrease when compared with fresh eggs but the eggs were still intact as regards the vitelline membrane and thick white.

Subjective Evaluation. The subjective evalution of broken at eggs indicates that the thick white of control eggs was irregular and was considerably thinned and mixed up with thin white even after 7 day storage. The yolk was also found to be mixed up with white after 14 days. When eggs were treated with 6 and 9% wax emulsion the yolk and white was found to be still intact even after 42 days of storage at 35°. This shows an improvement in egg quality after coating the eggs with wax emulsion at 6 and 9% levels as compared with the control one. Although the height of yolk was less than fresh ones, the eggs were worthy of consumption. This gives an indication that coating of eggs with 6 and 9% level exert considerable protective effect. No off-flavour was detected in eggs treated with 6 and 9% wax emulsion even after storage at 35° for 42 days.

Conclusions and General Remarks

The overall results indicate that wax emulsion at the concentration level of 9% gives some protection to the eggs stored at 35° for 42 days. These studies indicate that coating at 9% level can prevent the loss of weight of eggs by arresting the loss of water and CO_2 but the passage of water from egg white to egg yolk can not be prevented for longer storage periods specially at high temperature. The lowering of yolk and white indices of 6 and 9% wax-emulsion treated eggs is mainly due to the internal movement of water from white to yolk. It is envisaged that at room temperature and at refrigeration temperature coating with 9% or higher level may give protection to the eggs for longer periods. These aspects, however, need detailed investigation which are in progress and will be reported later. The wax emulsion developed is easy to apply and after drying it leaves a thin flim of wax.

Acknowledgement. The author's are grateful to Dr. A.F.Md. Ehteshamuddin for his keen interest and encouragement during these investigation.

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