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Systematic Literature Review on Preservative Effects of Oil on Egg Quality Traits of Chickens

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Abstract | The objective of this study was to systematically review the research published on the effect of the application of different oils on chicken egg quality traits. PubMed, Google Scholar, ScienceDirect and Web of Science were evaluated systematically using the combination of the following keywords: Chicken, storage methods, and egg quality traits. A total of 5 eligible articles published between 2013 and 2022 in Nigeria, Poland, Sri Lanka, and Egypt were included. The results showed that out of the 5 included articles, vegetable oil was the most used (n = 2), meanwhile mineral oil (n = 1), glycerol (n = 1) and coconut oil (n = 1) were the least used in the included articles. The results reported that eggs applied with glycerol and vegetable oils had a better egg weight after storage. It was further revealed that shell weight and thickness were not affected by the application of oils. The albumen pH and yolk pH of eggs applied with vegetable and coconut oil was low compared to those stored without application. The limitation of the current systematic review is the use of different oils which limits conducting the meta-analysis. The systematic review concluded that glycerol and vegetable oil influence retaining the egg weight of the stored eggs. Therefore, the oils may be used as a preservation method on eggs during storage. The findings may be used by farmers during the storage of eggs to improve the shelf life of the stored eggs.

Keywords | Chicken, Egg quality traits, Shelf life, Storage method, Oils

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INTRODUCTION

Eggs have not only been considered the most abundant source of food, but it is highly nutritious containing high levels of vitamins and minerals (Wahba *et al*., 2014; Oleforuh-Okoleh and Eze, 2016). Although eggs are one of the cheapest protein sources, like any other food, they have a limited shelf life (Oleforuh-Okoleh and Eze, 2016; Senevirathne *et al*., 2022). Several studies have been conducted on the preservation of egg-quality traits during storage using oil. Drabik *et al*. (2018) used Glycerinon commercial laying hens, Eke *et al*. (2013) used vegetable oil on freshly laid eggs purchased from the University of Agriculture Makurdi farm, Oleforuh-Okoleh and Eze (2016) applied vegetable oil (refined palm oil) on egg od Nigerian heavy chicken ecotype, Senevirathne *et al*. (2022) reported the use of coconut oil on Hy-line White layers and Wahba *et al*. (2014) applied s mineral oil on commercial hen eggs.

The results of the studies conducted are not conclusive. Hence, the current systematic review will report the effect of oil as a preservative for egg quality traits. Although they have been studies conducted, there is little evidence of literature documenting the use of different combinations of oils in the preservation of eggs in one setting. The objective of this systematic review was to review the literature on the preservative effects of oil on egg quality traits of chickens. This study will provide information to the researcher on which different oils may be profitable to use when storing eggs to conserve their internal and external quality traits.

MATERIAL AND METHODS

Eligibility Criteria

The identification of the Population, Intervention, Comparison and Outcomes (PICO) components of the research question were performed for this systematic review as outlined by Bettany-Saltikov (2010). The "Chicken" was defined as a population of the study, while the "egg stored in oil and room temperature" as an intervention, and the "egg quality traits" as an outcome. A preliminary search of the PICO component on ScienceDirect r was performed before deciding to conduct the study.

Search Strategy

A scientific publication search was performed independently by two investigators (Mokoena Kwena and Tyasi Thobela Louis) in databases from May 2023 to June 2023, using PubMed, Google Scholar, ScienceDirect and Web of Science. The search was performed using the combination of keywords as follows: "Chicken", "storage methods", and "egg quality traits". The key words were searched in different combinations, and only literature in English was considered in the study.

Inclusion Criteria

All articles recovered were screened for eligible studies according to several standards and considered for inclusion if they met the following criteria: chicken, storage methods, and egg quality traits were included in the context of the packaging method used.

Exclusion Criteria

The exclusion criteria of the current study contained: (1) records irrelevant to storage methods and egg quality traits, (2) records duplicated, (3) studies published as abstracts without the full text of the article, (4) Authors with no available original data in the publication and failure to contact the authors, and (5) studies not on chickens.

Data Extraction

The data for the current study was extracted independently by Mokoena Kwena and Tyasi Thobela Louis to avoid the risk biased selection of papers. The conflict between the two authors during screening was resolved through discussion of abstract and reaching a consensus decision. The information obtained from each article consisted of the first author, year of publication, number of eggs collected, the chicken breed used in the study, storage methods and egg quality traits.

Ethical Considerations

Authors considered plagiarism, misconduct, informed consent, data falsification, and fabrication when performing this systematic review. This was done by including peer reviewed articles. During the review process, the systematic review was subjected to turnitin software for plagiarism.

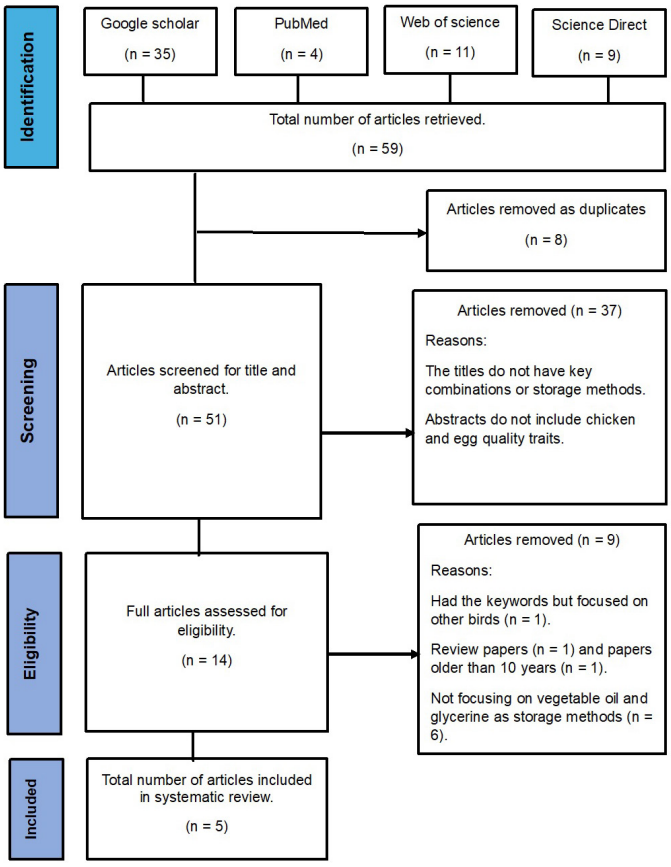

Figure 1: Flowchart of identification and selection of studies for systematic review.

RESULTS AND DISCUSSION

Searched Results

The flowchart of the identification and selection of studies for the systematic review is presented in Figure 1. A total of fifty-nine (n = 59) articles were retrieved from a publication search, where eight (n = 8) of the articles that were duplicated were removed. As a result, a total of fifty-one (n = 51) articles were considered for the selection of title and abstract, which resulted in thirty-seven (n = 37) articles eliminated after title and abstract review. Eight (n = 8) articles were eliminated after a full text- review, the reasons are

stated in Figure 1. A total of five (n = 5) articles qualified for inclusion in the study.

Characteristics of Included Studies

The five (n = 5) articles that were identified and met the criteria were appraised and considered for inclusion as depicted in Table 1. A total of 60% (3/5) of articles (Eke et al., 2013; Wahba *et al*., 2014; Drabik *et al*., 2018) were not specific on the breed of chicken used and was called a flock of commercial laying hens or table eggs or fresh commercial hen eggs of poultry farms, whereas 40% (2/5) of the articles (Senevirathne *et al*., 2022; Oleforuh-Okoleh and Eze, 2016) were specific on the breed used in the study.

Table 1: Characterization of included studies.

Authors	Year	Country	Sample size	Chicken breed
Drabik *et al*	2018	Poland	270	Commercial laying hens
Eke *et al*	2013	Nigeria	120	Laying hens
Oleforuh-Okoleh and Eze	2016	Nigeria	160	Nigerian Heavy chicken ecotype hen
Senevirathne *et al*	2022	Sri Lanka	210	Hy-line White layers
Wahba *et al*	2014	Egypt	75	Commercial hen

Publication by Year

All the articles included in the systematic review were published between 2013 and 2022 as shown in Figure 2. The results showed that the year 2013, 2014, 2016, 2018 and 2022 published 20% (1/5) of the included articles in each year.

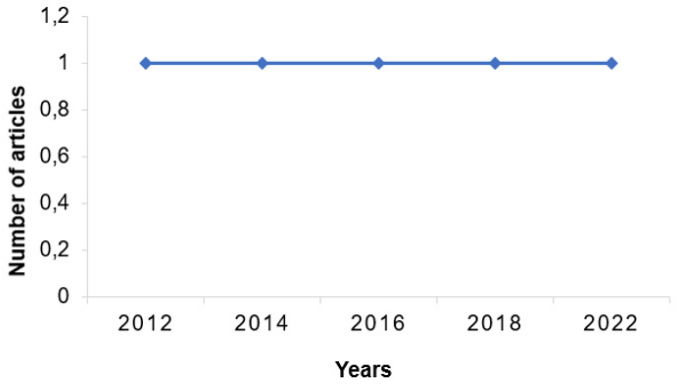

Figure 2: Publication by year.

Publication by County

The results indicated that five (n = 5) included articles were conducted in 4 different countries (Figure 3) and it was discovered that 40% (2/5) of articles (Eke et al., 2013; Oleforuh-Okoleh and Eze, 2016) were from Nigeria. The findings further showed that 20% (1/5) article (Drabik *et al*., 2018) was from Poland, 20% (1/5) from Sri Lanka (Senevirathne *et al*., 2022) and 20% (1/5) from Egypt (Wahba *et al*., 2014).

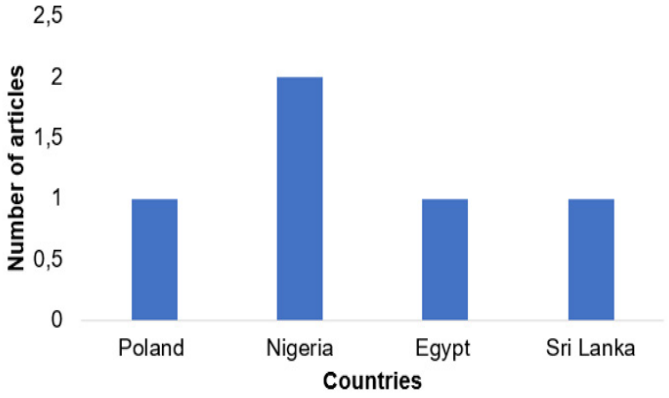

Figure 3: Publication by country.

Publication by Oil

The results indicated that all the included studies performed the experiment using different oils (Figure 4). Out of the 5 included articles in the study, 40% (2/5) of the articles (Eke et al., 2013; Oleforuh-Okoleh and Eze, 2016) used vegetable oil (n = 2). It was further discovered that 20% (1/5) article (Wahba *et al*., 2014) used mineral oil, 20% (1/5) article (Drabik *et al*., 2018) used glycerol and 20% (1/5) article (Senevirathne *et al*., 2022) used coconut oil.

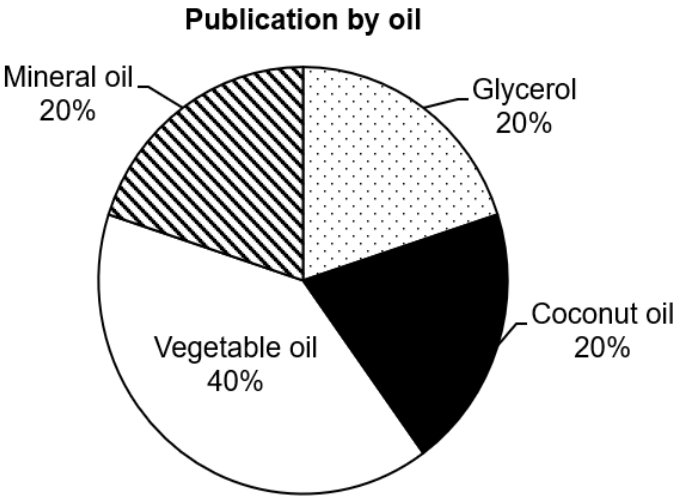

Figure 4: Publication by oil.

Effect of Oils on Egg Weight

Table 2 presents the effect of oil application on egg weight. The findings showed that out of the 5 included articles, 80% (4/5) of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016; Wahba *et al*., 2014; Eke *et al*., 2012) studied the effects of oils on the egg weight. The findings reported that 50% (2/4) of the articles (Oleforuh-Okoleh and Eze, 2016; Eke et al., 2013) used vegetable oils as a treatment, 25% (1/4) article (Drabik *et al*., 2018) used glycerol and 25% (1/4) article (Wahba *et al*., 2014) used mineral oil. The results showed that all included articles (100%) reported a significant difference ($p<0.05$) between treatment and control groups on egg weight. The results revealed that 50% (2/4) of the included article (Drabik *et al*., 2018; Eke et

al., 2013) found that oils had larger egg weight than control. While 50% (2/4) of the articles (Oleforuh-Okoleh and Eze, 2016; Wahba *et al*., 2014) showed that the control group had larger egg weight than oil treated group. The difference in the results may be due to difference in the oils applied to the eggs.

Table 2: Effect of oils on egg weight.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	60.59	-	-	61.22	-	*
Eke *et al*	2013	60	69	-	-	-	*
Oleforuh-Okoleh and Eze	2016	46.2	43.2	-	-	-	*
Wahba *et al*	2014	67.3	-	-	-	62.5	*

Table 3: Effect of oils on shell thickness.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	0.334	-	-	-	-	ns
Senevirathne *et al*	2022	0.54	0.52	-	-	-	*

Effect of Oils on Shell Thickness

The effects of oil application on shell thickness are shown in Table 3. The results indicated that from reviewed articles, 40% (2/5) of articles (Drabik *et al*., 2018; Senevirathne *et al*., 2022) out of 5 investigated the effect of oils on shell thickness. It was reported that 50% (1/2) articles (Senevirathne *et al*., 2022) reported a significant effect ($p<0.05$), meanwhile, 50% (1/2) (Drabik *et al*., 2018) reported a non-significance ($p>0.05$) on effects of oils on shell thickness. The results (Senevirathne *et al*., 2022) revealed that the control group had a thicker shell than the oil-treated group. This implies that the eggshell thickness was not improved by the application of oils.

Table 4: Effect of oils on shell weight.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	8.20	-	-	-	-	ns

Effect of Oils on Shell Weight

Table 4 shows the effect of oil application on shell weight. Out of 5 included articles, only 20% (1/5) of the articles (Drabik *et al*., 2018) investigated the effect of oils on shell weight. The article used glycerol oil as treatment. The results reported a non-significance ($p>0.05$) on eggshell weight, showing that eggshell weight was not affected by the oil application.

Effect of Oils on Albumen Weight

The effect of oil application on albumen weight is presented in Table 5 below. Out of 5 reviewed articles, 40% (2/5) of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) studied the effect of oils on albumen weight. The results showed that of the 2 studied articles, 50% (1/2) article (Drabik *et al*., 2018) focused on the application of glycerol on eggs, meanwhile, 50% (1/2) article (Oleforuh-Okoleh and Eze, 2016) focused on the application of vegetable oil. The results indicated a significant effect ($p<0.05$) on the albumen weight of eggs applied vegetable oil (Oleforuh-Okoleh and Eze, 2016) and a non-significant effect ($p>0.05$) on the albumen weight of eggs applied glycerol (Drabik *et al*., 2018). The findings of Oleforuh-Okoleh and Eze, (2016) revealed that the vegetable oil had heavier albumen weight than the control group. This may be due to the oil properties which protected the integrity of the albumen weight.

Table 5: Effect of oils on albumen weight.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	37.46	-	-	-	-	ns
Oleforuh-Okoleh and Eze	2016	20.2	20.6	-	-	-	*

Table 6: Effect of oils on yolk weight.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	15.22	-	-	-	-	*
Oleforuh-Okoleh and Eze	2016	9.09	8.73	-	-	-	*

Effect of Oils on Yolk Weight

Table 6 represents the effect of oil application on yolk weight. The results indicated that 40% (2/5) of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) out of 5 reviewed articles investigated the effect of oils on yolk weight. The results have shown that 100% (2/2) of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) reported a significant effect ($p<0.05$) on yolk weight. The results revealed that the control had a heavier yolk weight than the oil-treated groups (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016). The findings revealed that the eggs stored without application of oils had better yolk weight than those treated with oil. This variation my be due to temperatures during storage.

Effect of Oils on Haugh Unit

Out of 5 included articles, 80% (4/5) of articles (Senevirathne *et al*., 2022; Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016; Eke et al., 2013) investigated the effect of oil application on Haugh unit Table 7. The articles used control and treatments, with 50% (2/4) articles (Oleforuh-Okoleh and Eze, 2016; Eke et al., 2013) focusing on vegetable oils, 25% (1/4) article (Drabik *et al*., 2018) on glycerol and 25% (1/4) article (Senevirathne *et al*., 2022) on coconut oil. The results revealed a significant effect ($p<0.5$) on all the articles (100%). The results indicated that 75% (3/4) of the articles (Senevirathne *et al*., 2022; Oleforuh-Okoleh and Eze, 2016; Eke et al., 2013) showed that oil-treated groups had the highest Haugh unit, meanwhile, 25% (1/4) of the article (Drabik *et al*., 2018) reported control having the highest Haugh unit. The results implies that the application of oils will improve the Haugh units in storage of chicken eggs.

Table 7: Effect of oils on Haugh unit.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	90.50	-	-	-	-	*
Eke *et al*	2012	66	75	-	-	-	*
Oleforuh-Okoleh and Eze	2016	65.4	68.1	-	-	-	*
Senevirathne *et al*	2022	79.0	-	82.5	-	-	*

Table 8: Effect of oils on albumen pH.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	8.25	-	-	-	-	*
Oleforuh-Okoleh and Eze	2016	9.09	8.73	-	-	-	*
Senevirathne *et al*	2022	8.12	7.93	-	-	-	*

Effect of Oils on Albumen pH

Table 8 presents the effect of oil application on albumen pH. The findings revealed that 60% (3/5) of the articles (Senevirathne *et al*., 2022; Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) out of 5 included articles focused on the effect of oils on albumen pH. The results indicated that 100% (3/3) of the articles reported a significant effect ($p<0.05$) of oils on albumen pH. The findings show that 100% of the articles (Senevirathne *et al*., 2022; Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) reported that the control group had higher pH than the oil-treated group. The findings implies that the eggs stored without oil application had an increased albumen pH, while those treated with oil had lower albumen pH. This may be due to the chemical reactions between the egg surface and the egg contents.

Effect of Oils on Yolk pH

Out of the 5 included articles in the study, only 40% (2/5) of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) focused on the effect of oil application on yolk pH Table 9. The finding revealed that 50% (1/2) of the articles (Drabik *et al*., 2018) used glycerol, while 50% (1/2) (Oleforuh-Okoleh and Eze, 2016) used vegetable oil. The results reported a 100% (2/2) significant effect ($p<0.05$) on yolk pH in all the articles. The results further showed that 100% of the articles (Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) reported high pH in the control group. The eggs stored without oil application had higher yolk pH compared to those treated with oil.

Table 9: Effect of oils on yolk pH.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	6.29	-	-	-	-	*
Oleforuh-Okoleh and Eze	2016	7.85	7.13	-	-	-	*

Table 10: Effect of oils on egg weight loss.

Author	Year	Treatments					Significant
		Control	Vegetable oil	Coconut oil	Glycerol	Mineral oil	
Drabik *et al*	2018	3.90	-	-	3.30	-	*
Eke *et al*	2012	4.4	6.1	-	-	-	*
Oleforuh-Okoleh and Eze	2016	7.48	6.20	-	-	-	*
Senevirathne *et al*	2022	0.16	-	0.00	-	-	*

Effect of Oils on Egg Weight Loss

The effect of oil application on egg weight loss is presented in Table 10. The results indicated that out of 5 articles reviewed, 80% (4/5) of the articles (Senevirathne *et al*., 2022; Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016; Eke et al., 2013) investigated the effect of oils on egg weight loss. The results indicated that 100% (4/4) of the articles re-

ported a significant effect ($p<0.05$) on egg weight loss. The findings reported that 75% (3/4) of the articles (Senevirathne *et al*., 2022; Drabik *et al*., 2018; Oleforuh-Okoleh and Eze, 2016) revealed the highest egg weight loss in the control group, whereas 25% (1/4) of the articles (Eke et al., 2013) reported high egg weight loss in vegetable oil than the control group. The results implies that egg wight loss may be reduced in eggs applies with vegetable oil.

Poultry eggs serve as the cheapest, most acceptable and most affordable animal product which is highly nutritious (Oleforuh-Okoleh and Eze, 2016) and from the minute they are laid, some changes affect their quality (Drabik *et al*., 2018). The objective of this systematic review was to identify the effect of the application of different oils on chicken egg quality traits. The systematic review included a total of 5 articles. The results indicated vegetable oil, mineral oil, coconut oil and glycerol were used in the included articles as treatments. The results indicated that 2 articles (Eke et al., 2013; Oleforuh-Okoleh and Eze, 2016) suggested vegetable oil,1 article (Senevirathne *et al*., 2022) suggested glycerol and 1 article (Wahba *et al*., 2014) suggested mineral oil. The use of glycerol may contribute to slow changes in egg quality during storage by limiting the removal of carbon dioxide from the egg content (Drabik *et al*., 2018). Furthermore, Eke *et al*. (2013) indicated that the application of oils on eggs before storage can be used to ensure the retention of good-quality eggs. Oleforuh-Okoleh and Eze (2016) reported vegetable oil as a method of preserving weight loss and albumen weight in Nigerian Heavy chicken ecotype hen. It was reported that the eggs coated with coconut oil had a high Haugh unit (Senevirathne *et al*., 2022). The results may be due to the preservative characteristics within the oils used. Based on our knowledge, there is no systematic review on the effect of the application of different oils on the egg quality traits of chickens for comparison. The result of the study implies that different oils such as vegetable oil, mineral oil, coconut oil and glycerol may be used to preserve the quality of eggs during storage. The strength of the systematic review is that there is no similar systematic review conducted on the application of different oils on egg quality traits of chickens. The contribution of this study to the body of knowledge is that some substances might be applied to eggs to improve their shelf life. This systematic review narrows them down and shows which are the best in preservation of the egg qualities. The limitation of the study is that there are no articles that used similar oils which makes it difficult to conduct a meta-analysis of the effect of application of oils on egg quality traits during storage. It is recommended that glycerol and vegetable oil be used in the improvement of egg quality during storage, due to their influence in retaining the egg weight. Furthermore, more studies need to be conducted on the application of glycerol and vegetable oils in the preservation of egg quality traits during storage.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the systematic review reported that the use of glycerol and vegetable oil may be used during storage to preserve the quality of the eggs. The variation findings may be due to the limited number of articles included and the substance makeup of the different oils used in the study.

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NOVELTY STATEMENT

The shelf life of eggs is among the limitation in the communal farmers. the currnt systematic review critically reviewed the types of oil which can be used to preserve the quality of eggs.

AUTHOR'S CONTRIBUTIONS

Thobela Louis Tyasi designed the manuscript, Kwena Mokoena wrote the manuscript. Thobela Louis Tyasi read and approved the final manuscript.

Data Availability Statement

Data was searched from different search engines, and it is readily available online.

Conflict of Interest

Authors state no conflict of interest.

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