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Assessment of Echinacea purpurea and/ or green coffee extracts fortified Edible coating on enhancement of chicken fillet quality.

Fatma M. Mansour[1], Reham A. Amin[1], Mohebat A. Abd El-Aziz[2], Rasha Elsabagh[1]

[1] *Department of Meat Hygiene and Control, Faculty of Veterinary Medicine, Benha University*

[2] *Food Hygiene Department, Animal Health Research Institute, Egypt*

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ABSTRACT

Meat products are susceptible to contamination with spoilage and pathogenic bacteria that have risk to cause hazards to consumer. One of the novel strategies to control these hazards during food storage is using edible coating that can be fortified bioactive compounds. Aim of this study was to prepare a bioactive edible coating from Carboxy methyle cellulose fortified with *Echinacea purpurea* (EP) and green coffee (GC) extracts to evaluate their effects on microbiological, physicochemical, and sensory attributes of chilled chicken fillets. It was found that values of APC in coated groups were decreased in GC/CMC, EP/CMC, and GC/EP/CMC from 5.19, 5.15, 5.01 to 3.64, 3.29 and 3.01 (log cfu/g), respectively. While the values were decreased from 3.01, 2.95 and 2.75 to 2.79, 2.24 and 2.14 (log cfu/g) in GC/CMC, EP/CMC, and GC/EP/CMC coated groups, respectively. Moreover, the higher reduction of psychrotrophic and Staphylococcus counts appeared in GC/CMC, EP/CMC, and GC/EP/CMC coated groups. Concerning physicochemical and sensory quality, EP and GC coated groups showed accepted levels till 18th day of storage if compared to plain coated and uncoated groups that refused at 9th day of storage. Accordingly, CMC fortified with GC and EP enhanced microbiological, physicochemical, and sensory quality of chicken fillets.

1. INTRODUCTION

One of the most desired products is chicken meat, which is rich with protein, vitamins, minerals, essential fatty acids (Mingyuan *et al.*, 2020) and low cost of production (flatou *et al.*, 2014). Regards to its nutritive values, it is considered one of the highly perishable products that is susceptible to contamination with spoilage and pathogenic bacteria that has risk to cause hazards to consumer (Abdel-Naeem *et al.*, 2021). Many techniques have been applied to control the spoilage and microbial contamination of meat (Aguilar *et al.*, 2021). Nowadays, edible coating is used to control food deterioration during storage, and CMC considered as the most potential coating-based material that can be incorporated with different antioxidants, antimicrobials, and texture enhancers (Panahirad *et al.*, 2021). Edible coating can be fortified with active ingredients such as flavorings, colorings and sweeteners enhancing the nutritional and sensory attributes of products (Dhall, 2016). It also enhances shelf-life of different perishable products (MdNorand Ding, 2020). Nowadays, consumer's awareness has been increased towards safe food, free from microbes, stable, and free from chemical preservatives (Kamat and Balasubramaniam, 2020). Natural antimicrobials and antioxidants have no negative impacts on human health, in contrast to chemical additives. Plant extracts has a great antimicrobial effect to be widely used in the industry (Zhang *et al.*,2020). Therefore, food producers directed to use those natural preservatives to meet consumer's demands.

Echinacea purpurea (EP) is one of herbal medicine that it enhances the immunity to relieve migraine anxiety, respiratory tract infections and stimulate healing of wound (Sharif, M*et al.*, 2021). It has antibacterial, antioxidant and anti-proliferative effects (Sharif, *et al.*, 2021). It considers one of the herbal drugs in different societies. In 2018, its sales reach over than $110 million to be the second top selling Botanical dietary supplements for human (Smith *et al.*, 2019).

Moreover, green coffee (GC) extract has a great interest in food industry as one of natural antimicrobial agent (Canci *et al.*, 2022). Moreover, it has antioxidant effects that enhances the sensory attributes, scavenging ability, oxidative stability and decreased the microbial count in meat ball (Mostafa and El Azab, 2022).

Application of such bio active compounds in edible coating becomes a trend in food industry to fulfill consumer demands for safe and high-quality meat products. So, the aim of this study was to (i) prepare a bioactive edible coating from CMC fortified with EP and GC extracts (ii) evaluate the effect of application of edible coating on microbiological quality of refrigerated chicken fillet refrigerated (ii) assess the enhancement of physic-chemical and sensory attributes of chilled chicken fillets by bioactive edible coating.

* Corresponding author: mansourfatma566@gmail.com

2. MATERIAL AND METHODS

2.1. Plant extracts:
Two naturally prepared plant extracts were used; *Echinacea purpurea* (EP). Their extraction and purification were performed according to Jiang et al. (2021). preparation of echnaciea and green coffee in chemistry lab of animal health research institute.

2.2. Edible coating preparation:
CMC edible coating was prepared according to Hebeish et al. (2010) to be supplemented with green coffee and/ or *Echinacea purpurea* (EP).

2.3. Experimental design:
Different types of previously prepared CMC edible coatings on chicken meat fillet samples that were freshly obtained from local supermarkets of Menofiya governorate, Egypt. Meat fillets samples were divided into five main groups. 1st group (uncoated chicken fillets), 2nd group (plain CMC coated chicken fillets), 3rd group (GC/CMC coated chicken fillets), 4th group (EP/CMC coated chicken fillets) and 5th group mixture (GC/EP/CMC coated chicken fillets). Samples were placed into plastic trays, sealed kept at 4 °C till spoilage of all samples. The samples were analyzed at 0, 3, 6, 9, 12, 15 and 18 days of storage. This study was repeated three times.

2.4. Microbiological quality evaluation:
Chicken fillet samples were examined periodically at 0, 3, 6, 9, 12, 15 and 18 days of storage for evaluation of Aerobic Plate Count Using pour plate surface plate method at 35^0c (ISO 4833-1, 2013), coliforms count Using violet red bile agar (VRB) at 37^0c for 24hr (ISO 4832, 2006), *Staphylococcal* count on Baired Parker ager medium incubated at 37^0C for 48 hours (FDA, 2001), and psychotrophic bacterial counts on aerobic plate count for 4^0C(FDA, 2001).

2.5. Physico-chemical evaluation:
The pH values were determined according to the method described in Zenebon *et al*. (2008), the content of TVB-N was performed following the method described by AOAC (2005) and expressed as mg N/100 g of sample. While the oxidative state of the samples was evaluated by the determination of the thiobarbituric acid reactive substances (TBARS) values according to AOAC (2005).

2.6. Sensory evaluation:
Sensory grades were evaluated according to ISO13299 (2003) to chicken fillets samples**.**

2.7. Statistical analysis:
Data was analyzed using the graph pad prism application for Windows. While analysis of variance (ANOVA) was performed on all data (Version 8.0.2(. values means and SD were expressed. Significant F-values were found at $p \leq 0.05$**.**

3. RESULTS

Microbiological quality evaluation:
Results in table (1) revealed the mean values of APC (log cfu/g). A significant difference between different groups was detected. Values were increased from 5.22 to 7.01 and 5.2 to 6.85 (log cfu/g) in uncoated chicken fillet and plain coated ones, respectively. While values of APC were decreased in GC/CMC, EP/CMC, and GC/EP/CMC coated groups from 5.19, 5.15, 5.01 to 3.64, 3.29, and 3.01 (log cfu/g), respectively.
Concerning coliform counts represented in table (2), the data showed that values were significantly differ (p value < 0.05) between groups at 6th day of storage; as the values were decreased from 3.01, 2.95 and 2.75 to 2.79, 2.24 and 2.14 (log cfu/g) in GC/CMC, EP/CMC, and GC/EP/CMC coated groups, respectively .While, uncoated and plain coated groups showed an increase in values from 3.16 and 3.2 to 4.21 and 3.99 (log cfu/g), respectively.
Effect of CMC different coats on psychrotrophic count was shown in table (3). The higher effect was appeared in GC/CMC, EP/CMC, and GC/EP/CMC coated groups. While uncoated and CMC plain coat has no reduction effect on psychrotrophic count.
Results in table (4) indicated that the effect of coats on staphylococcal count. Values increased from 3.25 ± 0.2^a, $3.25\pm0.1^a$to 4.71, 4.6 log (cfu/g) in uncoated chicken fillet and plain coated groups. While values decrease in GC/CMC, EP/CMC, and GC/EP/CMC coated groups.

Table 1 Effects of CMC edible coating supplemented with GC and/or EP on APC (log cfu/g) in chilled chicken fillets (n=3).

Storage period Groups	Zero day	3rd day	6th day	9th day	12th day	15th day	18th day
Uncoated	5.22±0.11 a	5.59±0.3 a	6.21±0.1 c	6.73±0.3 c	6.88±0.12 c	6.97±0.1 c	7.01±0.14 c
Plain CMC coating	5.2±0.23 a	5.35±0.4 a	5.63±0.15 a	6.01±0.32 c	6.22±0.17c	6.55±0.08 c	6.85±0.11 c
GC/CMC	5.19±0.04 a	5.01±0.1 ab	4.79±0.2 b	4.41±0.12 b	4.11±0.08 d	3.95±0.1 d	3.64±0.04 de
EP/CMC	5.15±0.2 a	4.9±0.09 b	4.54±0.16 b	4.21±0.05 b	3.95±0.04 d	3.6±0.09 d	3.29±0.1 f
GC/EP/CMC	5.01±0.1 a	4.75±0.08 b	4.41±0.22 b	4.05±0.09 b	3.73±0.03 d	3.15±0.06 e	3.01±0.02 g

Three experiments findings are shown as Mean ±Standard Deviation (SD). Different letters that follow Means within a column are significantly different (p ≤ 0.05).

Table 2 Effects of CMC edible coating supplemented with GC and/or EP on Coliform count (log cfu/g) in chilled chicken fillets (n=3).

Storage period Groups	Zero day	3rd day	6th day	9th day	12th day	15th day	18th day
Uncoated	3.16±0.1a	3.97±0.22a	4.21±0.4a	4.93±0.22e	5.14±0.4e	5.57±0.5e	5.9±1.1e
Plain CMC coating	3.2±0.11a	3.65±0.18a	3.99±0.2a	4.42±0.3e	4.9±0.14e	5.15±0.23e	5.6±0.9e
GC/CMC	3.14±0.14a	3.01±0.3a	2.79±0.11b	2.4±0.12bc	2.06±0.22bc	1.51±0.14d	ND
EP/CMC	3.16±0.3a	2.95±0.09ab	2.24±0.14b	2.01±0.02bc	1.94±0.03d	ND	ND
GC/EP/CMC	3.15±0.2a	2.75±0.05ab	2.14±0.21b	1.99±0.09bc	ND	ND	ND

Table 3 Effects of CMC edible coating supplemented with GC and/or EP on psychrotrophic count (log cfu/g) in chilled chicken fillets (n=3).

Storage period Groups	Zero day	3rd day	6th day	9th day	12th day	15th day	18th day
uncoated	2.66±0.02^{a}	3.05±0.1^{b}	3.39±0.13^{d}	3.98±0.2^{d}	3.97±0.41^{d}	4.03±0.19^{d}	4.65±0.31^{d}
Plain CMC coating	2.66±0.02^{a}	2.99±0.3^{b}	3.11±0.14^{d}	3.66±0.08d	3.95±0.4^{d}	ND	ND
GC/CMC	2.66±0.02^{a}	2.27±0.01^{bc}	2.07±0.02^{c}	1.9±0.4^{c}	ND	ND	ND
EP/CMC	2.66±0.02^{a}	2.14±0.09^{bc}	2.01±0.04^{c}	1.89±0.16^{c}	ND	ND	ND
GC/EP/CMC	2.66±0.02^{a}	2.11±0.08^{c}	1.85±0.06^{c}	ND	ND	ND	ND

Three experiments findings are shown as Mean ±Standard Deviation (SD). Different letters that follow Means within a column are significantly different ($p \leq 0.05$)

Table 4 Effects of CMC edible coating supplemented with GC and/or EP on Staphylococcal count (log cfu/g) in chilled chicken fillets (n=3).

Storage period Groups/	Zero day	3rd day	6th day	9th day	12th day	15th day	18th day
uncoated	3.25±0.2^{a}	3.57±0.3^{b}	3.91±0.14^{b}	4.01±0.5^{b}	4.24±0.31^{b}	4.57±0.4^{b}	4.71±0.9
Plain CMC coating	3.25±0.1^{a}	3.31±0.7^{b}	3.65±0.3^{b}	3.96±0.4^{b}	4.04±0.25^{b}	4.25±0.19^{b}	4.6±0.16
GC/CMC	3.21±0.09^{a}	3.03±0.02^{a}	2.81±0.04^{c}	2.54±0.12^{c}	2.18±0.18^{c}	1.59±0.11^{d}	ND
EP/CMC	3.20±0.02^{a}	2.75±0.03^{a}	2.14±0.02^{c}	2.11±0.21^{c}	1.99±0.14^{d}	ND	ND
GC/EP/CMC	3.19±0.01^{a}	2.51±0.11^{a}	2.02±0.01^{c}	1.60±0.14^{d}	ND	ND	ND

Three experiments findings are expressed as Mean ±Standard Deviation (SD). Different letters that follow Means within a column are significantly different ($p \leq 0.05$).

Physicochemical evaluation:

Results in figure (1) illustrated effect of CMC coating on physic-chemical characters (pH, TBA, TVN). There was a significant increase in three parameters in un-coated and plain coated CMC chicken fillets to be rejected at 9th day of storage. While those coated with GC/CMC, EP/CMC, and GC/EP/CMC showed a delay in physicochemical changes and stay with in normal levels till day 18 of storage.

Results in table (5) revealed the desired effect of GC/CMC, EP/CMC, and GC/EP/CMC edible coats on sensory acceptability of refrigerated chicken fillet to be accepted till 18th day of storage.

Table 5 Effects of CMC edible coating supplemented with GC and/or EP on sensory and overall acceptability of chilled chicken fillets (n=3).

Storage period Groups	zero day	3rd day	6th day	9th day	12th day	15th day	18th day
uncoated	9. 5 ± 0.08^{a}	6.9 ± 0.33^{b}	4.5 ± 0.06^{a}	3.10 ± 0.09^{a}	2.5 ± 0.06^{a}	2 ± 0.08^{a}	1.5 ± 0.10^{a}
Plain CMC coating	9.4 ± 0.03^{a}	8.6 ± 0.11^{a}	7.9 ± 0.29^{b}	6.6 ± 0.13^{b}	5 ± 0.16^{b}	4.5 ± 0.39^{b}	3 ± 0.06^{b}
GC/CMC	9.1 ± 0.03^{a}	8.7 ± 0.29^{a}	8.2 ± 0.30^{b}	7.5 ± 0.09^{bc}	6.9 ± 0.15^{c}	5.2 ± 0.26^{c}	4.3 ± 0.06^{d}
EP/CMC	9.1 ± 0.28^{a}	8.8 ± 0.06^{a}	8.4 ± 0.16^{b}	8 ± 0.48^{c}	7.2 ± 0.12^{d}	5.5 ± 0.06^{d}	4.6 ± 0.12^{e}
GC/EP/CMC	9.1 ± 0.03^{a}	8.9 ± 0.12^{a}	8.5 ± 0.13^{b}	8.1 ± 0.06^{c}	7.3 ± 0.14^{d}	5.9 ± 0.06^{e}	5 ± 0.14^{f}

Three experiments findings are expressed as Mean ±Standard Deviation (SD). Different letters that follow Means within a column are significantly different ($p \leq 0.05$).

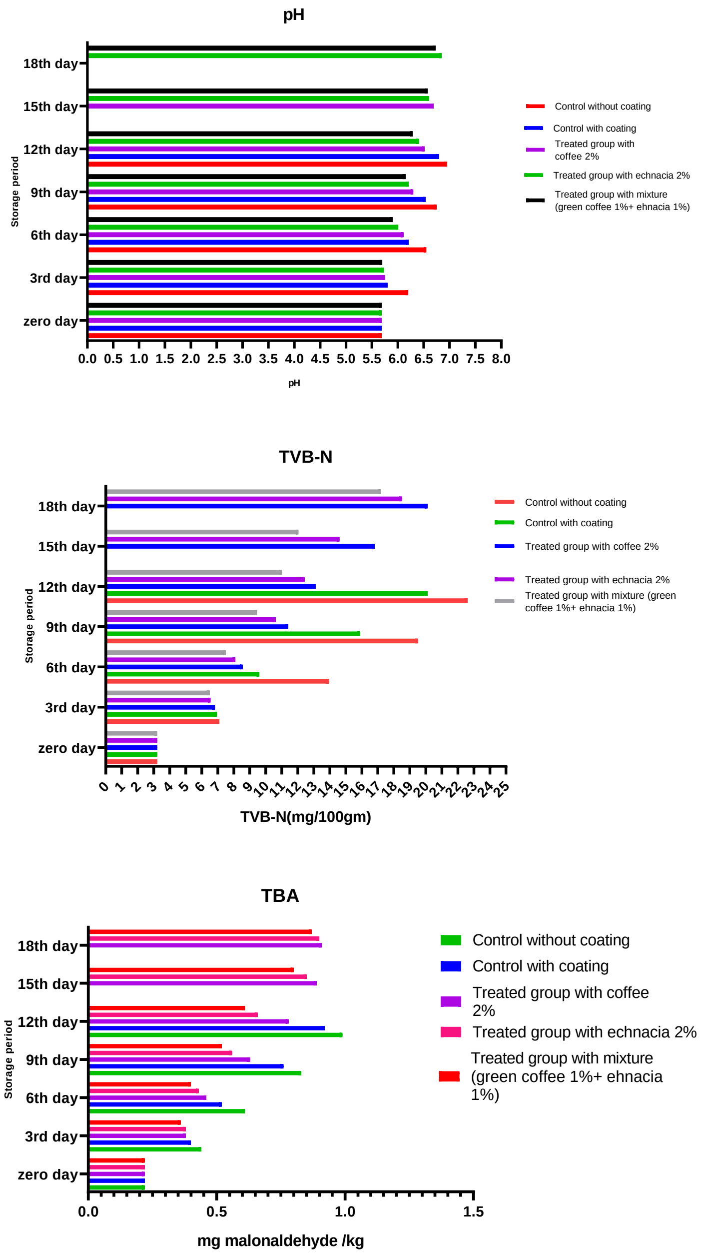

Figure 1 effects of CMC edible coating supplemented with GC and/or EP on pH, TBA, TVN in chilled chicken fillets (n=3).

Sensory evaluation:

4. DISCUSSION

Growing demands about using natural preservatives instead of synthetic ones in food sector has increased, nowadays (Thuong *et al*., 2022). One of the novel applications in food preservation is coating. CMC is one of the most effective coating materials in carrying natural bioactive compounds to food products, it carries functional antimicrobial, and antioxidant compounds (Panahirad *et al.,* 2021). In this study, different CMC edible coatings supplemented with GC and/or EP were applied on chicken fillet stored refrigerated at 4C. It was found that GC/CMC, EP/CMC, and GC/EP/CMC edible˚coating enhanced bacteriological quality of chicken fillets. It shows a significant effect on APC, coliform counts, psychrotrophic count, and staphylococcal count. This owing to that incorporation of CMC edible coating with natural antibacterial greatly enhanced the bacterial profile of different meat products (Khezrian and Shahbazi, 2018; Priyadarshi *et al.*, 2021) As, EP extracts has antibacterial effect against most of bacteria as; *E. coli*, *B. subtilis*, and *S. aureus* and that confirmed by Rehman *et al*. (2012). Moreover, GC has a broad-spectrum antibacterial Suárez-Quiroz et al. (2013). They contain many active Phenylpropanoids compounds as caffeic acid (Gowtham *et al*. 2020, Zaushintsena *et al.* 2019). Phenolic compounds are not only having antimicrobial effect but also antioxidant effect. It recently used as antioxidant in meat industry (Xie *et al.*, 2017). This antioxidant capacity of GC and EP reflected in physicochemical attributes (pH, TBA, TVN) of GC/CMC, EP/CMC, and GC/EP/CMC coated chicken fillet. This agrees with Qian et al. (2021). Moreover, shelf lifetime of those chicken fillets samples coated with GC/CMC, EP/CMC, and GC/EP/CMC extended to reach 18 days of refrigerated storage at 4C̊ also, it was found that edible coating with bioactive compounds like EP/GC improved sensory attributes of chicken meat fillets over long storage period to be accepted till day 18th of storage. These results of enhancement of edible coating to bacterial quality and shelf lifetime agree with those of Qian et al. (2021) in fresh pork. CMC coating is a safe and highly nutritive way of meat preservation. The European Food Safety Authority evaluates the safety of CMCs in the European Commission in 2018 (Younes *et al.,* 2018). Moreover, it is accepted as "generally regarded as safe" in the food area (Zhang *et al.*, 2021).

5. CONCLUSION

According to the obtained results, one can conclude that CMC edible coating supplemented with green coffee and /or *Echinacea purpurea* enhanced microbiological, physicochemical quality of chilled chicken fillets. Moreover, it increased acceptability of the products and shelf lifetime to reach about 18 days of storage at refrigerated temperatures.

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