J.Meat Sci., 2016, 11 (2) : 40 - 44

Research Paper

Evaluation of Edible Polymer Coatings Enriched with Grape Seed Extract on Chicken Meat Nuggets

***K. Prathyusha, E. Naga Mallika, B. Eswara Rao, T. Srinivas Rao**

Department of Livestock Products Technology
NTR CVSc, Gannavaram, Andhra Pradesh

ABSTRACT

The study aims at the preservation of quality and extension of shelf life of chicken meat nuggets by formulating a novel coating material made of edible polymers. Edible polymer sodium alginate was used which was enriched with grape seed extract for the shelf life extension of the coated chicken meat nuggets. The quality of the nuggets was studied in terms of pH, Thiobarbituric acid value, Peroxide value, Total Plate Count, Water loss analysis and sensory evaluation at both refrigeration (4±1°C) and frozen storage (-18±1°C) temperatures. Results indicated that the polymer coatings extended the shelf life of the nuggets. Nuggets coated with grape seed extract incorporated coating solution had a lower TBARS values, peroxide values, total plate counts when compared to the nuggets coated with sodium alginate and the control group. Sensory attributes like color, flavor, tenderness, juiciness and overall acceptability also differed significantly ($p<0.05$) for coated nuggets. Under refrigerated storage nuggets coated with grape seed extract incorporated coating solution recorded a shelf life of 15 days whereas their controls recorded only 10 days of storage period and under frozen storage grape seed coated nuggets recorded 75 days against their controls with 60 days.

Keywords : *Chicken nuggets, Grape seed extract, Edible coatings, Sodium alginate.*

Received : 06.07.2015 Accepted: 31.01.2016

INTRODUCTION

Food packaging is the topic of interest in these days in meat sector vowing to the consumer safety and environmental pollution caused by the packaging materials. Many materials have been researched which can effectively replace the conventional packaging materials. Many biodegradable films are being researched from natural polymers like carbohydrates, proteins and lipids (Durango *et al*. 2006; Seacheol *et al*. 2008). Biodegradable edible films and coatings prepared from carbohydrates show excellent film forming ability because of their unique colloidal properties and are able to yield tough and flexible transparent films due to their linear structure in their backbone (Krumel and Lindsay 1976). Alginate is a polysaccharide extracted from brown seaweed (*Phaeophyceae*), consists of linearly (1-4) linked polyuronic acid containing three types of block structures: poly-b-D-manno pyranosyl uronic acid (M) blocks, poly-a-L-gulopyranosyluronic acid (G) blocks and MG blocks containing both polyuronic acids. It is a common gelling ingredient used in the food industry (Mancini and McHugh 2000). Alginate possess a great characteristic of reacting with polyvalent metal cations specifically calcium to form strong gel and insoluble films with enhanced water resistance (Pavlath *et al*.1999). Hence these films can be enriched with additives like antioxidants (Le Tien *et al*.2001), antimicrobials, coloring agents and essential oils (Ozdemir and Floros 2004). Grape (*Vitis vinifera*) seed extracts contain 74 to 78% oligomeric proantho cyanidins and less than approximately 6% of free flavanol monomers on a dry weight basis (Burdock 2005). Proantho cyanidins in the form of monomeric phenolic compounds, such as catechin, epicatechin and epicatechin-3-O-gallate, and in dimeric, trimeric and tetrameric procyanidin forms are rich in GSE. These can combine with gallic acid to form gallate esters and ultimately glycosides (Weber *et al.* 2007).The incorporation of antimicrobial and/or antioxidant compounds of natural origin into the coatings is an interesting way to enhance functional properties.Thus, the objective of this work was to exploit the beneficial effect of sodium alginate, as a coating and carrier of grape seed extract to improve the quality and to extend the shelf life of chicken meat nuggets.

MATERIALS AND METHODS

Fresh chicken meat was procured from local market. All chemicals utilized for evaluation of the quality characteristics of chicken meat nuggets were procured from Himedia laboratories Pvt. Ltd. Natural antioxidants like lyophilized Grape seed powder (90% anthocyanidines) was purchased from Kamco pharmaceuticals, Hyderabad. The chicken nuggets were prepared by adding minced meat and other ingredients of recipe in a sequential order. Minced meat was chopped in bowl chopper by adding the ingredients namely salt, fat, binder (corn flour), spice and chilli powder,

*Corresponding author E-mail address : prathyusha.vet@gmail.com

condiments and water in the form of crushed ice at 1.8, 5.0, 3.0, 2.2, 4.0 and 10.0 percent respectively and during chopping, the emulsion was maintained at 10-12°C by addition of crushed ice. The emulsion was filled in the steel mould and cooked at 75±2°C for 45 minute then made into pieces to form nuggets.

Sodium alginate at a concentration of 2% (w/v) in distilled water was melted with continuous stirring to allow hydrolysation by heating to 90°C on magnetic stirrer, the temperature was brought down to 70°C and glycerin was added as plasticizer at 4 % level and grape seed extract at 1% level was also added slowly with continuous stirring. Two types of edible coating solutions were produced i.e without additives (T1), with incorporation of 1% grape seed extract (T2). Chicken nuggets prepared according to the method described were coated with the coating solutions by dipping in the coating solutions for one minute, drained of excess solution for 30 seconds, followed by dipping in 2% aqueous calcium chloride ($CaCl_2$) solution for 30 seconds. Coated nuggets were kept in hot air oven at 40°C for 30 minutes for efficient casting of coating over the nuggets. The coated nuggets along with control (C) were packed in LDPE covers, labeled and stored at refrigeration temperature (4±1°C) and frozen temperature (-18±1°C). They were analyzed at regular intervals of 5 days and 15 days at refrigeration and frozen temperatures, respectively for physicochemical, microbiological and sensory characters.

The percent moisture, fat and crude protein were estimated as per AOAC (1995). pH of the preparation was estimated by following the method of Trout *et al*. (1992) using digital pH meter of (Oakton Instruments, USA). The distillation method outlined by Tarladgis *et al*. (1960) was followed for the determination of TBARS values. Peroxide value of the product was determined by standard technique of AOAC (1995). Microbiological analysis was carried out according APHA (1984).

The nuggets were cooked and subjected to a 6 member taste panel for sensory evaluation to evaluate color, appearance, flavor, juiciness, tenderness and overall acceptability on a 9 point hedonic scale (Peryam and Pilgrim 1957). The data was subjected the statistical analysis using SPSS MAC, version 22.0, SPSS Chicago (US). The entire experiment was repeated six times to reduce the standard error.

RESULTS AND DISCUSSION

***pH*:** The pH values of the nuggets during both the storage temperatures (Table 1 and 2), increased which may be due to microbial production of alkalinizing substances however alginate coated nuggets showed a slower rate of increase in the pH values than the control nuggets showing a significant difference ($p<0.05$) between the pH values of coated and control chicken meat nuggets. This observation was similar to Chidanandaiah *et al.* (2009) in beef patties, Yongling et *al.* (2011) on refrigerated bream with sodium alginate coatings.

***The TBA values*:** The nuggets coated with GSE showed significantly lower values than others (Table 1and 2) at both the storage temperatures. The values of treated and control nuggets increased continuously during both storage temperatures which may be attributed to partial dehydration of the product and increased oxidation of unsaturated fatty acids. Alginate coated nuggets recorded significantly ($p<0.05$) lower values when compared to the control group. This might be due to the sodium alginate coating having a base of strongly cross linked polymers which resisted the oxygen diffusion. The values of grape seed enriched coatings were significantly ($p<0.05$) lower than that of uncoated samples as well as coatings without grape seed throughout the storage period indicating the efficacy of antioxidants of GSE added into the coating in inhibiting lipid oxidation. In this study the initial TBA values of the coated nuggets was in the range of 0.99 mg MDA / kg and the value exceed 2 mg MDA / kg on day 15 at refrigerated storage for control samples, however, the TBA values of T2 were well below these levels on day 15. Similar pattern in results were observed by Wu *et al*. (2001) for pre-cooked ground-beef patties packaged in edible starch-alginate-based films, Chidanandaiah *et al.* (2009) in alginate coated beef patties, Lee *et al.* (2004) with chitosan coatings on herring cod, Shon and Chin (2008) with whey protein coating on sausages, Yongling *et al.* (2011) with sodium alginate based coatings incorporated with tea polyphenols and vitamin C on refrigerated bream.

***The peroxide values*:** Significant lower peroxide values ($p<0.05$) were recorded in coated nuggets. Peroxides formed as the intermediates in the auto oxidation begin to disintegrate into aldehydes, ketones and TBA but in coated samples due to the properties of sodium alginate and antioxidants GSE in edible coatings the increase of TBA and peroxides was prevented. Irrespective of temperature of storage the peroxide values increased with increasing storage period (Table 1 and 2). These results were in agreement with Jeon *et al.* (2002) using chitosan coatings on herring and atlantic cod, Shon and Chin (2008) with whey protein coating on sausages, Jinhan *et al.* (2010) on soy protein isolated coatings on beef and Rostami *et al.* (2010) on whey protein coated gutted kilka during frozen storage.

Table 1: Effect of sodium alginate coating enriched with grape seed extract on pH, TBA and PV of chicken meat nuggets at refrigerated storage temperature (4± 1°C)(Mean±SD)

	pH			TBA (mg MDA/Kg)			PV meq/kg fat		
Days	C	T1 (SA)	T2 (SA+GSE)	C	T1 (SA)	T2 (SA+GSE)	C	T1 (SA)	T2 (SA+GSE)
0	6.25±0.05	5.96±0.04	5.93±0.04[a]	0.98±0.04	1.00±0.02	1.00±0.04[a]	0.68±0.03	0.69±0.04	0.68±0.02[a]
5	6.33±0.02	6.15±0.03	6.14±0.03[b]	1.21±0.03	1.11±0.05	1.09±0.04[b]	1.42±0.02	1.12±0.04	0.92±0.02[b]
10	*6.38±0.03	6.24±0.04	6.24±0.05[c]	*1.86±0.03	1.47±0.04	1.44±0.04[c]	*2.52±0.04	1.88±0.03	1.44±0.04[c]
15		*6.35±0.03	6.31±0.01[d]		*1.90±0.05	1.63±0.03[d]		*2.69±0.01	2.45±0.03[d]

n=6; C= Control without preservative, T1= 2% sodium alginate, T2 = 2% sodium alginate with 1% grape seed extract, TBA= Thiobarbituric acid value, PV= Peroxide value, SA= Sodium alginate, GSE= Grape seed extract
Means with different superscripts (in the same column) differ significantly ($p<0.01$). * spoiled

Table 2: Effect of sodium alginate coating enriched with grape seed extract on chicken meat nuggets on pH, TBA and PV at frozen storage temperature (-18± 1°C) (Mean±SD)

	pH			TBA (mg MDA/Kg)			PV meq/kg fat		
Days	C	T1 (SA)	T2 (SA+GSE)	C	T1 (SA)	T2 (SA+GSE)	C	T1 (SA)	T2 (SA+GSE)
0	6.25±0.05	5.96±0.04	5.93±0.04[a]	0.98±0.04	1.00±0.02	0.99±0.04[a]	0.68±0.03	0.69±0.04	0.70±0.02[a]
15	6.32±0.01	6.29±0.03	6.28±0.04[b]	1.22±0.02	1.14±0.01	1.12±0.04[b]	0.89±0.02	0.77±0.01	0.75±0.03[b]
30	6.44±0.02	6.41± 0.03	6.37±0.01[c]	1.34±0.04	1.29±0.05	1.19±0.04[c]	1.33±0.04	1.25±0.03	1.16±0.04[c]
45	6.56±0.02	6.49±0.02	6.43±0.02[d]	1.45±0.03	1.39±0.04	1.33±0.05[d]	1.52±0.05	1.47±0.04	1.38±0.04[d]
	*6.72±0.03	6.53±0.04	6.53±0.03[e]	*1.74±0.02	1.59±0.02	1.42±0.03[e]	*2.68±0.02	2.32±0.03	2.26±0.02[e]
		*6.81± 0.04	6.58±0.02[f]		*1.66±0.04	1.62±0.03[f]		*2.70±0.04	2.57±0.03[f]
			*6.72±0.04[g]			*1.76±0.01[g]			*2.88±0.05[g]

n=6; C= Control without preservative, T1= 2% sodium alginate, T2 = 2% sodium alginate with 1% grape seed extract , Means with different superscripts (small letters in the same column) differ significantly ($p<0.01$). * spoiled SA= Sodium alginate, GSE= Grape seed extract

The TPC values: Total plate count (TPC) values were significantly ($p<0.05$) lower in coated samples enriched with GSE than the control samples (Table 3 and 4). This might be due to the ability of sodium alginate and calcium interlinking enriched with antioxidants reduce microorganism infiltration into coated samples (Fang and Tsai 2003). During storage at both temperatures the total plate counts increased with increasing storage period. However, lower counts of treatment samples were noticed in comparison with controls. Further values of T2 were significantly ($p<0.05$) lower than the control and T1 formulations. There was an increase in the shelf life of 5 days at refrigerated storage temperature and 15 days at frozen storage temperatures. This marginal improvement in microbial quality might be due to the effect of proantho cyanidins that are present in grape seed extract which were proved to possess certain antimicrobial activity (Gadang *et al.* 2008). The results were similar to Natrajan and Sheldon (2000) with incorporation of nisin and chelators into protein and polysaccharide-based films inhibiting growth of *Salmonella* on poultry skin. Cagri *et al.* (2002) with whey protein isolate (WPI) containing sorbic acid and p-aminobenzoic acid in inhibiting the growth of bacteria and Siripatrawan and Noipha (2012) who incorporated green tea extract in active film from chitosan of pork sausages.

Table 3: Effect of sodium alginate coating enriched with grape seed extract on TPC of chicken meat nuggets at refrigerated storage temperature (4± 1°C) (Mean±SD)

	TPC		
Days	C	T1 (SA)	T2 (SA+GSE)
0	4.54±0.04	4.53±0.03	4.02±0.01[a]
5	4.84±0.04	4.52±0.03	4.12±0.03[b]
10	*5.83±0.01	4.95±0.02	4.50±0.04[c]
15		*5.03±0.04	4.81±0.03[d]

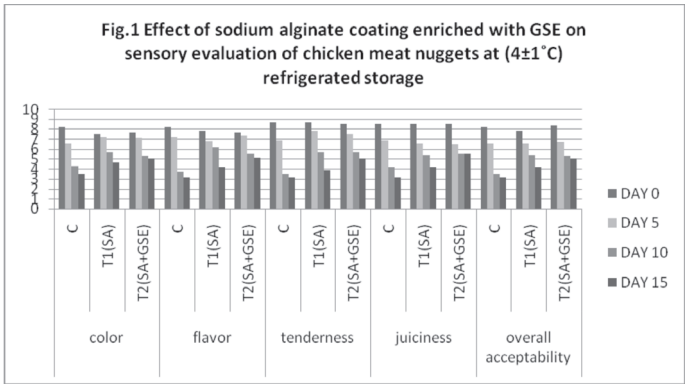
n=6; C= Control without preservative, T1= 2% sodium alginate, T2 = 2% sodium alginate with 1% grape seed extract , Means with different superscripts (in the same column) differ significantly ($p<0.01$). * spoiled

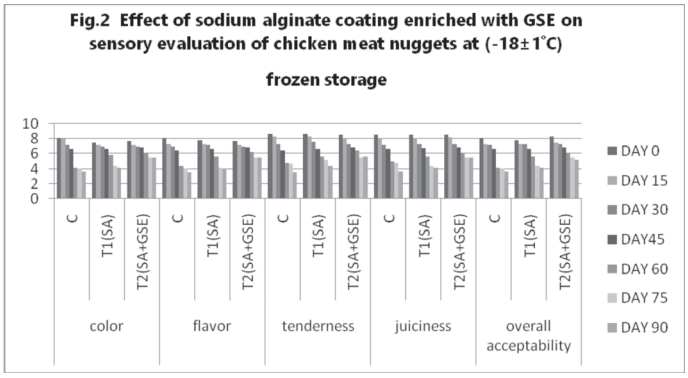
Table 4: Effect of sodium alginate coating enriched with grape seed extract on TPC of chicken meat nuggets during storage at frozen temperature (-18± 1°C)(Mean±SD)

	TPC		
Days	C	T1 (SA)	T2 (SA+GSE)
0	4.54±0.04	4.53±0.03	4.03±0.01[a]
15	4.62±0.02	4.53±0.03	4.25±0.01[b]
30	4.85±0.03	4.62±0.03	4.30±0.05[c]
45	4.98±0.03	4.72±0.04	4.55±0.05[d]
60	*5.73±0.03	4.95±0.04	4.73±0.03[e]
75		*5.08±0.03	4.95±0.01[f]
90			*5.09±0.05[g]

n=6; C= Control without preservative, T1= 2% sodium alginate, T2 = 2% sodium alginate with 1% grape seed extract , Means with different superscripts (in the same column) differ significantly ($p<0.01$). * spoiled

***Sensory evaluation values*:** The nuggets coated with alginate based coating recorded significantly ($p<0.05$) higher mean color, flavor, tenderness, juiciness and overall acceptability scores than the control nuggets at both refrigerated and frozen storages (Fig 1 and 2).





The higher color scores would have been due to the properties of polysaccharide films i.e preventing dehydration, oxidative rancidity and surface browning.

Flavor: Better flavor scores for coated nuggets which may be attributed to the coating of sodium alginate which was considered as flavoring agent (Seifzadeh *et al.* 2007). When compared to T1 the lower scores of T2 even though were non-significant can be attributed to the retarded oxidation due to the antioxidants.

Juiciness: The higher juiciness scores might be due to retention of more moisture in the coated product. In addition to this, prevention of tissue dehydration by myofibril denaturation and hydrophilic nature of sodium alginate molecules may also aid in increased juiciness.

Overall acceptability: Higher overall acceptability can be attributed to the reduced loss of volatile compounds while cooking in these products (Gennadios *et al.* 1997). Irrespective of the type of coating and storage temperature the sensory evaluation scores significantly ($p<0.05$) decreased with increase in the storage period. Sensory evaluation scores were in agreement with Yongling *et al.* (2011) on refrigerated bream with sodium alginate based coatings, Siripatrawan and Noipha (2012) with chitosan green tea film and Chidanandaiah *et al*. (2009) who reported that the sodium alginate coating at 2% level significantly ($p<0.05$) improved the overall appearance and colour, juiciness, flavour, texture and overall palatability of beef patties.

Proximate composition values: The per cent moisture content of the coated nuggets was higher than the uncoated ones (Table 5). This can be attributed to the fact that gel coating which acts as sacrificing agent i.e., moisture in the gel evaporates prior to any significant dessication of the enrobed food (Kester and Fenamma 1986). No difference in the protein and fat content of the coated and uncoated product was found indicating that the coatings did not affect the protein and fat content of the product. Similar results were also observed by Chidanandaiah *et al.* (2009) who stated that coating of beef patties did not have significant effect on protein content when the alginate content is 2% level in the coating.

Table 5: Effect of sodium alginate coating enriched with grape seed extract on proximate composition of chicken meat nuggets (Mean±SD)

	TPC		
Days	**C**	**T1 (SA)**	**T2 (SA+GSE)**
Moisture	68.75 ± 0.05^{a}	70.54 ± 0.04^{b}	71.91 ± 0.06^{b}
Protein	19.92 ± 0.07^{x}	19.88 ± 0.01^{x}	19.94 ± 0.05^{x}
Fat	3.35 ± 0.14^{a}	3.38 ± 0.13^{a}	3.36 ± 0.08^{a}

n=6; C= Control without preservative, T1= 2% sodium alginate, T2 = 2% sodium alginate with 1% grape seed extract , Means with different superscripts (small letters in the same column) differ significantly ($p<0.01$). * spoiled

CONCLUSION

Based on the results of the study it may be concluded that edible coatings with sodium alginate can effectively inhibit lipid oxidation and microbial growth thus, extending the shelf life of the product. It can also suggest potential application of edible coatings as antioxidant carriers as to further extend the shelf life of the coated product.

REFERENCES

AOAC (1995) Official Methods of Analysis, 6th edition. Association of official analytical chemists, Maryland, USA

APHA (1984) Compendium of methods for the microbiological examination of foods, 2nd edition. American public health association, Washinton DC, USA

Burdock GA (2005) Fenaroli's handbook of flavor ingredients. BocaRaton, Florida -33431, USA: CRC Press

Cagri A, Ustunol Z, Ryser E (2002) Inhibition of three pathogens on bologna and summer sausage slices using antimicrobial edible films. J Food Sci 67: 2317 – 2324

Chidanandaiah KRC, Sanyal MK (2009) Effect of sodium alginate coating with preservatives on the quality of meat patties during refrigerated (4 ± 1°C) storage. J Muscle Foods 20: 275-292

Durango AM, Soares NFF, Andrade NJ (2006) Microbiological evaluation of an edible antimicrobial coating on minimally processed carrots. Food Control 17: 336–341

Fang TJ, Tsai HC (2003) Growth patterns of *Escherichia coli* O157:H7 in ground beef treated with nisin, chelators, organic acids and their combinations immobilized in calcium alginate gel. Food Microbio l20:243–253

Gadang VP, Hettiarachchy NS, Johnson MG, Owens C (2008) Evaluation of antibacterial activity of whey protein isolate coating incorporated with nisin, grape seed extract, malic acid and EDTA on a turkey frankfurter system. J Food Sci 73: M389–M394

Gennadios A, Hanna MA, Kurth LB (1997) Application of edible coatings on meat, poultry and seafoods: A review. Lebensmittel-Wissenschaft and Technologie 30: 337–350

Jeon YJ, Kamil JYVA, Shahidi F (2002) Chitosan as an edible invisible film for quality preservation of herring and Atlantic cod. J Agri Food Chem 50:5167–5178

Jinhan Shon, Ji-hyun Eo, Jong-Bang Eun (2010) Effect of soy protein isolate coating on quality attributes of cut raw han-woo (korean cow) beef, aerobically packaged and held refrigerated. J Food Quality 33(1): 42–60

Kester JJ, Fennema OR (1986) Edible films and coatings: A review. Food Technol 40(12): 47-59

Krumel KL, Lindsay TA (1976) Nonionic cellulose ethers. Food Technol 30: 36–43

Le Tien C, Vachon C, Mateescu MA, Lacroix M (2001) Milk protein coatings prevent oxidative browning of apples and potatoes. J Food Sci 66: 512–516

Lee CH, An DS, Lee SC, Park H J, Lee DS (2004) A coating for use as an antimicrobial and antioxidative packaging material incorporating nisin and a-tocopherol. J Food Engg 62:323–329

Mancini F, Mchugh TH (2000) Fruit-alginate interactions in novel restructured products. Nahrung-Food 44: 152–157

Natrajan N, Sheldon BW (2000) Inhibition of *Salmonella* on poultry skin using protein and polysaccharide-based films containing nisin formulation. J Food Prot 63: 1268 – 1272

Ozdemir M, Floros JD (2004) Active food packaging technologies. Crit Rev Food Sci Nutr 44: 185–193

Pavlath AE, Gossett C, Camirand W, Robertson GH (1999) Innomeric films of alginic acid. J Food Sci 64: 61–63

Peryam DR, Pilgrim FJ (1957) Hedonic scale method of measuring food preferences. Food Technol (9): 9-14

Rostami H, Motallebi AA, Khanipour AA, Soltani M, Khanedan N (2010) Effect of whey protein coating on physico-chemical properties of gutted Kilka during frozen storage. Iranian J Fisheries Sci 9: 412-421

Seacheol M, Tom RR, John MK (2008) Diffusion of the antimicrobial lysozyme from a whey protein coating on smoked salmon. J Food Engg 84: 39–47

Seifzadeh M (2007) Application of edible films in fish products packaging. J World Aquac 7:34-40

Shon J, Chin KB (2008) Effect of whey protein coating on quality attributes of low-fat, aerobically packaged sausage during refrigerated storage. J Food Sci 73:469-475

Siripatrawan U, Noipha S (2012) Active film from chitosan incorporating green tea extract for shelf life extension of pork sausages. Food Hydrocoll 27:102–108

Tarladgis BG, Watts BM, Younatham MT, Dugan LR (1960) A distillation method for the quantitative determination of malonaldehyde in rancid foods. J Am Oil Chem Soc 37: 44-48

Trout ES, Hunt NC, Jhonson DE, Claus JR, Kastner CL, Kropf DH (1992) Chemical, physical and sensory characterization of ground beef containing 5 to 30% fat. J Food Sci 57:25-29

Weber HA, Hodges AE, Guthrie JR, Obrien BM, Robaugh D, Clark AP, Harries RK, Algaier JW, Smith CS (2007) Comparison of proanthocyanidins in commercial antioxidants: Grape seed and pine bark extracts. J Agrc Food Chem 55: 148–156

Wu Y, Weller CL, Hamouz F, Cuppett S, Schnepf M (2001) Moisture loss and lipid oxidation for precooked ground-beef patties packaged in edible starch-alginate-based composite films. J Food Sci 66: 486–493

Yongling S, Lei L, Huixing S, Juan Y, Yongkang L (2011) Effect of sodium alginate-based edible coating containing different anti-oxidants on quality and shelf life of refrigerated bream (*Megalobrama amblycephala*). Food Control 22: 608-615