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Effect of Gum Arabic (*Acacia Senegal*) Powder Coating and Sun Drying Period on the Chemical Composition and Colour of Dehydrated Camel Meat

Tyseer Zakaria Abdalla [1] and **Ikhlas Ahmed Nour**[2]

1. [1]Department of milk production science and technology, Collage of animal production science and technology, Sudan University of Science and Technology
2. [2]Department of Meat Production, Faculty of Animal Production, University of Khartoum

Corresponding Author: tyseer27@gmail.com.

ABSTRACT:

This study was conducted to evaluate the effect of gum Arabic (Acacia Senegal) powder coating level (GAL) and sun drying period (DP) on chemical composition and colour of dry camel meat. Ten Kg camel round cut were prepared into thin strips, 1x1x10 cm, divided into 3groups with 4 replicates. The Gum Arabic was blended to smooth powder, GAL (0% controls, 5% and 10%) and 3 drying periods (0 fresh, 48 and 96 hours) were studied. Chemical composition and objective color were determined. Data were analyzed as 3× 3 factorial designs using SPSS version 11.5 computer program. The results revealed that the interaction between the GAL and the DP was significant (P<0.05) in the moisture content and lightness (L*) color. Increasing both GAL and DP resulted in a significant reduction of the moisture content and lightness color (L*). The 10% GAL dried for 96hrs presented the lowest moisture (10.48), the protein and ash contents of the 5% and the control were not significantly different. The 10% GAL coating gave the highest protein (58.29%) and ash (4.01) and the lowest fat (2.72) percentages. Increasing the DP to 96 hrs resulted in a significantly lowest percentage of moisture (10.82) and highest protein (77.43), fat (4.35) and ash (5.01). Increasing the GAL resulted in a non-significant (p>0.05) increase of redness (a*) and decreased yellowness (b*). The study concluded that Gum Arabic powder as natural edible coating improved the nutritional value and appearance, of sun dried camel meat.

Key words: dry camel meat gum Arabic coating

Introduction:

Camel meat is a potential alternative for beef particularly in arid/semi-arid regions where camels are usually bred (Rashed, 2002). Camel lean meat contains about 78% water, 19% protein, 3% fat, and 1.2% ash with a small amount of intramuscular fat, which renders it a healthy food for humans. Meat protein also plays important physiological role as it promotes iron absorption and prevents calcium losses. Dromedary meat composition is generally similar to other red meat animals where there is an inverse correlation between the moisture and fat contents and it varied according to breed, age, sex, condition and site on the carcass. Moisture content plays an important role in preserving and eating qualities of dromedary meat (Kadim *et al.*, 2008). The demand for high quality, safety and extended shelf life of meat and fish was increased thus numerous preservation technologies such as super chilling, high hydrostatic pressure, radiation, chemical active and modified atmosphere packaging were used or proposed (Panagiotis et al., 2002; Hugas et al., 2002; Zhou, 2010). One of the major problems of the food industry is the preservation of meat and meat products. Several efforts for finding methods to preserve foods in a natural way have been made. FAO(2001) reported that in the

Journal of Camel Research and Production
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http:// journals.sustech.edu

absence of a cold chain, meat drying remains the most practical way of preserving and storing meat in developing countries with warm climate. Such methods are the application of natural antimicrobial substances like organic acids, bacteriocins, food grade enzymes or essential oils, which have gained increasing attention as means of naturally controlling the growth of spoilage or pathogenic microorganisms (Mataragas *et al.*, 2003). Ayanwale et al., (2007) studied the effect of sun-drying (33°C for 120 hrs) and oven-drying (60°C for 72 hrs) on the nutritive value of meat strips from chicken, beef and chevron. He found that oven-drying and sun-drying increased significantly (P<0.05) the dry matter and protein contents of the dried samples compared to the fresh samples while fat, carbohydrates and energy (Kcal/g) were significantly (P<0.05) higher in the fresh meat samples than the dried samples. The sun-dried samples had higher functional properties, proteins, acceptability level, but lower fat than the oven-dried samples. Dehydration reduces sample weight which is an important consideration when shipping and eliminates the need for refrigeration, making it easier to pre-mix retail products (Adam, 2004).

The simple dehydration or drying of lean meat under natural conditions has been practiced for centuries. It is still a popular method in many developing countries and Sudan, in particular where no cold chain is available. It is predominantly carried out for meat preservation, based on the experience that dehydrated meat will not spoil easily. Nowadays, extensive research is being done in bio edible coating or film to delay or prevent the spoilage of most perishable food. These coatings acts as an envelope to prevent the exchange of transfer of gasses (Bourtoom, 2008) and acts like a barrier for aromatic compounds, thus preventing quality changes in food (Miller and Krochta, 1997). Gum arabic (GA) known as acacia gum, is a mixture of poly-saccharides and glycoprotein obtained from the stems and branches of Acacia Senegal and Acacia Seyal. It is widely used in food industry as a stabilizer, thickening agent and as an emulsifier in soft drinks, syrup, gummy candies, textile, pottery, cosmetics and pharmaceutical industries. Polysaccharide matrices are able to encapsulate aroma compounds and entrap active ingredients, thereby enhancing safety and nutritional and sensory attributes (Falguera et al., 2011).

The objective of this study is to evaluate the effect of gum Arabic (Acacia Senegal) powder as a bioedible coating (GAL) and sun drying period (DP) on chemical composition and colour of dry camel meat.

Materials and Methods

Experimental meat:-

Fresh deboned camel meat from the round cut (8 Kg) was purchased from Abuzaid (2kg at a time) meat market at Omdruman, Khartoum state. The samples were wrapped in clean sterile polyethylene bags and transported in a clean cool box containing ice cubes to the meat laboratory of the Department of meat production, faculty of Animal Production, University of Khartoum. Then the samples were trimmed of fat, connective tissues and kept in a refrigerator until used next morning.

Sun drier:

A metal frame sun-dryer (solar drier) consisted of 3 shelves was prepared and covered all around with wire net mish to prevent entry of insects, birds and any other predators and permit entry of direct sun and air current on the meat strip. The meat strips were suspended in the sun-dryer using cotton thread loops.

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Preparation of gum Arabic powder:
Gum Arabic (Acacia Senegal) was obtained from Elobied town market, North Kordofan state, cleaned from any impurities, cut into small pieces, air dried and blended by kitchen blender to smooth powder. Three levels of Gum Arabic (GA) powder w/w, 0% (control), 5% and 10% were used.

Sample Preparation:
To insure adequate dehydration of the meat, samples were prepared for the drying process by slicing them into thin strip of 1x1x10 cm, divided into 3equal groups according to the gum Arabic powder coating level (0% control, 5% and 10%) used. Each group was divided into 3equal groups according to the drying period o hours (fresh), 48 hrs and 96 hours. Then suspended from one end in the sun drier and dried under direct influence of sun rays, natural temperature, humidity and circulation of the air for 6 hour (from 9 am to 3pm) and returned to the laboratory room every day. After the required drying period was finished the dried meat strips were analysis for moisture, crude protein, fat , ash and colour.

Proximate chemical analysis:
Determination of total moisture, crude protein, fat (ether extract) and ash of the samples were performed according to (A.O.A.C,2004).

Moisture determination:-
Five grams of each sample was put weighted clean crucible dried in an oven at 100°c overnight, then the samples were taken out of the oven and cooled in a desiccator. The loss of weight was considered as the moisture content. The moisture% was calculated as follows:-

Moisture% = weight of sample before drying – weight of dried sample ×100
Weight of the sample before drying

Crude protein determination:-

Kjeldahl method was used to determine nitrogen content. Crude protein was determined by multiplying the amount of nitrogen times 6.25.One gram of each sample was digested in Kjeldahl flask by adding 10gm of catalysts (mercury) and 25ml conc. H2So4. The mixture was heated for 3 hours, the digested samples were cooled and then 100ml of distilled water was added to each flask. Fifty ml of boric acid containing methyl blue were placed under condenser of each distilled unit. The mixture was then titrated against 0.1N HCl. The formula used for calculation of crude protein was as follows:-

Nitrogen content % = Tv× N × 14 × 100
1000 × wt. of sample

Where:-

Tv: Actual volume of HCl used for titration.

N : Normality of HCl.

14: Each ml of HCl is equivalent to 14mg nitrogen.

1000: To convert from mg to g.

Crude Protein% = Nitrogen% × 6.25

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Fat determination:-

Fat was determined by Soxhlet extraction using petroleum ether. Two grams of minced sample coated by filter paper was put in a clean weighed dry soxhlet extraction flask. The fat was extracted from samples for 6 hours using petroleum ether (boiling point 60-80o C). After extraction the petroleum ether in the extraction flask was evaporated. Then the flask dried in a 100oC oven for 30 minutes till no traces of ether remained, cooled in desiccators and weighed, the difference in weight was considered as the fat content. The calculation was done as the following:

Fat% = Fat weight × 100

Sample weight

Ash determination:-

Two grams of samples were placed into dried crucible of known weight. The crucibles were placed inside a muffle furnace at 150°c. The temperature was increased gradually till it reached 600°C and the sample were heated for 3hrs until white grey ash was obtained. Then the crucible were taken out, cooled into a desiccator and weighed. The ash percentage was calculated by the following equation:-

Ash% =weight of sample after drying × 100

weight of sample before drying

Objective color measurement:

The values of color component lightness (L*) redness (a*) and yellowness (b*) of the dry camel meat samples were determined using a Hunter lab Tri-Stimulus colorimeter Model D25.L

Results

Statistical analysis reveal that there is a significant(P<0.05) interaction between the added gum Arabic powder coating levels (GAL) and the drying period(DP) in the moisture content and lightness (L*) color of dry camel meat.

As seen from table (1) there is a significant interaction between the added Gum Arabic powder coating level and the drying period resulted in a significant (P<0.001) decrease of the moisture percentage with increasing both of the GAL and DP of the dry camel meat. The control in all the tested drying periods and added GAL give a significantly (P<0.001) highest moisture % which was not significantly different (P>0.01) from the 5% Gum Arabic powder treatm ent but significantly ((P<0.01)) different from the 10% treatment which present the lowest moisture % among all the treatments.

Journal of Camel Research and Production
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Table (1): Effect of Gum Arabic coating level and drying period on moisture

Dependable variables	GAL (%)	Drying period (hours) 0	48	96	SE	Main effects DP	GAL	Interaction DP x GAL
Moisture (%)	0	75.54^{a}	15.88^{b}	11.59^{c}				
	5	74.15^{a}	15.11^{b}	10.55^{c}	0.32	***	***	***
	10	71.53^{d}	14.83^{e}	10.48^{f}				
Protein (%)	0	22.95	73.57	77.48	0.32			
	5	23.03	74.04	77.70		***	NS	NS
	10	23.09	74.14	77.74				
Fat (%)	0	1.36	3.13	4.52	0.17			
	5	1.41	2.89	4.35		***	NS	NS
	10	1.47	2.50	4.14				
Ash (%)	0	1.71	4.32	4.75	0.15			
	5	2.03	4.66	5.22		***	**	NS
	10	2.06	4.94	5.04				

[abc]Means within the same row or column having different superscripts are significantly different
SE±: standard error ; NS: not significant ; *** P≤0.001; ** P≤0. 01
GAL: Gum Arabic powder level ; DP: drying period ; GAL x DP: Interaction

Increasing the added GAL resulted in a significant (P<0.05) decrease of the moisture% but this decrease was not significant between the control (0 level) and the 5% level. The protein % increased not significantly (P>0.05) , ash% increased significantly (P<0.05) and the fat% decreased significantly (P<0.05) with increasing the GAL % . The 10% the added GAL resulted in a significantly (P<0.05) lowest moisture and fat%, a significantly (P<0.05) highest ash content and a non significant (P>0.05) increase of the protein % among the treatments (table 2). Increasing the DP to 96 hour resulted in a significantly (P<0. 01) lowest moisture% and a significantly (P<0. 01) highest protein, fat and ash contents of the dry camel meat (table 2).

Table (2) Main Effect of gum Arabic powder coating level and drying period on dry camel meat chemical composition

Main effects	Parameter	Moisture	Protein	Fat	Ash
Gum Arabic added level (%)	0	34.05^{a}	57.88^{a}	3.01^{b}	3.60^{a}
	5	33.55^{a}	58.08^{a}	2.88^{ab}	3.97^{bc}
	10	32.23^{b}	58.29^{a}	2.72^{a}	4.01^{c}
	SE	0.18	0.18	0.10	0.08
	LS	**	NS	**	**
Drying period (hours)	0	73.73^{a}	22.90^{a}	1.41^{a}	1.93^{a}
	48	15.27^{b}	73.91^{b}	2.84^{b}	4.64^{b}
	96	10.82^{c}	77.43^{c}	4.35^{c}	5.01^{c}
	SE	0.26	0.26	0.14	0.12
	LS	***	***	***	***

Journal of Camel Research and Production
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[abc]Means within the same row or column having different superscripts are significantly different
SE±: standard error ; NS: not significant ; *** P≤0.001
** P≤0. 01

Objective color measurements

Statistical analysis reveal a significant (P<0.05) interaction between the added gum Arabic powder coating levels (GAL) and the drying period (DP) in lightness (L*) color of dry camel meat **.** Figure (1) show that the lightness color (L*) value decreased significantly (p<0.01) with increasing the DP in all the GAL treatments. The control (0%GAP) showed non-significant (P>0.05) reduction in L* value compared with the 5%and 10%GAP at 0hours. At 48hours DP L* value decreased highly significant in all the GAL treatments. , the control (0%GAP) showed a significantly (p<0.01) high L* compared with the other levels of gum Arabic powder. The 10% GAL had the lowest L*value at 96hoursDP.

Increasing the GAL powder resulted in a non-significant (p>0.01) increase of the a* value (redness) with increasing the GAL% and the DP .The b*value (yellowness) decreased non-significant (p>0.01) with increasing the GAL% and the DP (Table 3).

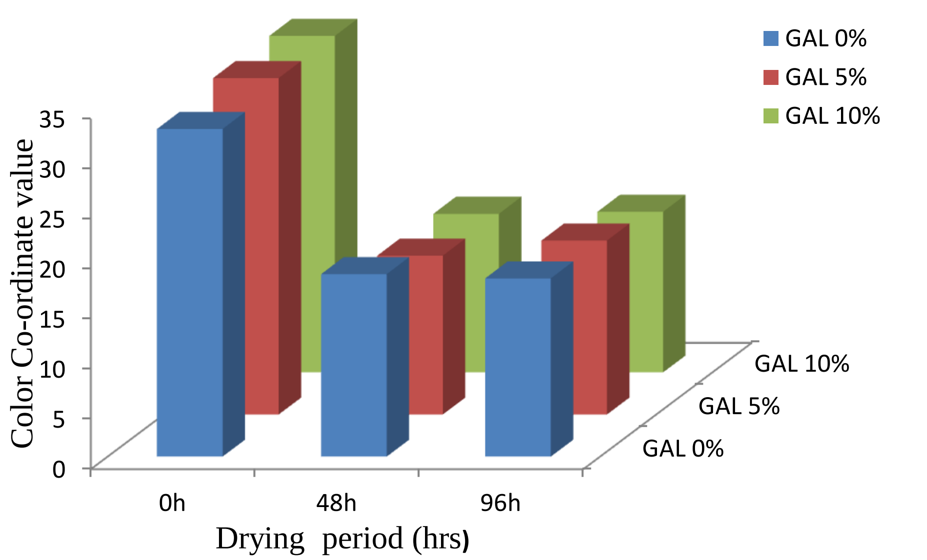

Figure 1: L*color of camel meat as affected by drying period(hrs) and added gum arabic powder level(GAL%)

Table (3):Effect of adding different levels of gum Arabic powder coating on **objective color measurements of dehydrated** camel meat

Journal of Camel Research and Production
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Drying period (hours)	Gum Arabic level (%)	L* (lightness)	a* (redness)	b* (yellowness)
	0	32.75[a]	13.23[a]	5.08[a]
	5	33.60[a]	15.15[a]	4.98[a]
0	10	33.55[a]	14.89[a]	4.76[a]
	SE±	0.24	0.34	0.17
	LS	NS	*	NS
	0	18.33[a]	15.40[a]	3.98[a]
	5	15.93[b]	15.68[a]	3.60[a]
48	10	15.85[b]	15.71[a]	3.48[a]
	SE±	0.44	0.14	0.26
	LS	**	NS	NS
	0	17.90[a]	15.53[a]	6.53[a]
	5	17.43[a]	15.82[a]	5.40[b]
96	10	16.03[a]	15.96[a]	4.90[b]
	SE±	0.42	0.18	0.24
	LS	NS	NS	**

Discussion

Statistical analysis of the data reveal a significant($P<0.05$)interaction between the added gum Arabic powder coating levels (GAL) and the drying period(DP) in the moisture content and lightness (L*) color of dry camel meat. Increasing both Gum Arabic powder coating level and the drying period resulted in a significant reduction of the moisture percentage .The 10% GAL dried for 96hrs present the lowest moisture %, among all the treatments. The lightness color (L*) value decreased significantly with increasing the DP in all the GAL treatments. The control (0%GAP) showed non-significant reduction in L* value compared with the 5%and 10%GAP at zero hours. The increase L* value could be attributed to the fact that Gum Arabic creating a thin transparent adhesive films over the surface

Journal of Camel Research and Production
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http:// journals.sustech.edu

of the rehydrated camel meat. The results were in line with Asgar et.al (2010) who stated that Gum Arabic used as a novel edible coating for enhancing shelf-life. The results were in line with Yousif .A (2011) who found that Sun drying when coupled with gum Arabic coating had no effect on quality attributes which can be considered as a simple and effective method for farmers and rural families to preserve their product for better in come by preventing postharvest losses during storage. Also with Krochta JM, de Mulder-Johnston C.(1997) who stated that coatings can protect food products from moisture migration, and can act as barriers against oils, gases, and vapors and as carriers of active substances. Drying has been used in the food industry as a mean to prevent growth of spoilage and pathogenic microorganisms in foods, (Davidson and Taylor, 2007; Farkas, 2007). Moisture content of the final product at 96hours in this study was 10.55%and 10.48% for treatments of 5%and 10% gum Arabic powder respectively, these values were in the limit with the value (10%) performed by the Sudanese Standard and Metrology (2009).

The GAL coating and DP as main effects had a significant impact on the chemical composition of dehydrated camel meat. Increasing the added GAL to 10% resulted in a significant decrease of the moisture and fat% and a non significant increase of the protein and a significant increase of the ash%. The 10% added GAL coating had the lowest moisture and fat%, and highest ash and protein contents. The control and the 5%GALtreatment were not significantly different in the moisture, protein and fat percentage but the 5%treatment had a significant increase of the ash%. Increasing the DP to 96 hour resulted in a significantly lowest moisture% and highest protein, fat and ash contents of the dry camel meat. The changes in the chemical composition of the dehydrated camel meat were attributed to the continuous evaporation and weight losses during drying which cause physical and biochemical changes of the meat and the chemical composition of the gum arabic. The results were in line with FAO(1990) who reported that continuous evaporation and weight losses during drying cause physical changes and also certain specific biochemical reactions with strong impact on the organoleptic characteristic of the

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product. These results agreed with Pace, et al. (1989) who indicated that in most instances proximate nutrients, such as crude protein and minerals increased due to loss of moisture . Malek et al,(2009)studied Effects of method of drying beef and buffalo meat and storage time on quality and found that the dry matter (DM), protein, ether extract (EE) and ash content decreased with storage time and the initial DM, crude protein (CP), EE and ash content of the beef and baffalo were 92.1-95.2%, 77.0-78.6%, 5.0-6.5%, 8.0-12.8%, respectively. Ayanwale *et al.*, (2007) studied the effect of sun-drying and oven-drying on the nutritive value of meat strips from chicken, beef and chevon showed that oven-drying and sun-drying increased ($p<0.05$) the dry matter and protein contents of the dried samples. The sun-dried samples had higher ($p<0.05$) functional properties, proteins, acceptability level, but lower fat than the oven-dried samples. Also this result was in agreement with Suad(1994); who studied composition of dry camel meat and reported a decrease in moisture and an increase in protein , fat and ash percentages with increasing the drying time from 2.5 to 3 hours in an oven .Also in line with Halima, (2013) who showed that there was a general decrease in moisture and an increase in protein , fat and ash content of the meat with increase time of drying. The results agreed with Asma and Nour (2013) who found that moisture and protein percentage increased significantly , fat, shrinkage and cooking loss percentage decreased significantly and ash increased not significantly as the level of Gum Arabic increased in beef burgers .

Increasing the GAL powder resulted in a non-significant ($p>0.01$) increase of the a* value (redness) with increasing the GAL% and the DP.The b*value (yellowness) decreased non-significantly with increasing the GAL% and the DP. This may be due to the fact that camel meat contains a higher level of "myoglobin" that interacts for a longer period with oxygen . The colour of meat depends on many factors such as concentration of harmonic pigment particularly myoglobin, the physical characteristics of the meat, essentially pH and the chemical state of these pigment(Gatellier *et al.*, 2001). The results agreed with Han JH, Gennadios A,(2005) who stated that edible coating enhance the quality of food products, protecting them from physical, chemical, and biological

Journal of Camel Research and Production
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deterioration. Also agreed with Al-Gadi, (2007)who reported that the color of camel meat sustains its redness up to five days of storage, it contains a higher level of "myoglobin" that interacts for a longer period with oxygen bright red pieces of meat show that it is fresh and obtained from a young animal. The findings were in concordance with Yousif .A (2011) who found that sun drying when coupled with gum Arabic coating had no effect on quality attributes of tomato which can be considered as a simple and effective method for farmers and rural families to preserve their product preventing postharvest losses during storage.

CONCLUSION

On the basis of the results of this study we can conclude that coating of dehydrated camel meat with Gum Arabic powder forms a thin transparent layer on the product surface which improves its appearance and act as a preservative of color. Increasing the level of gum Arabic coating percentage had a significant reduction of the dry meat fat content .The dry camel meat coated with 10% gum Arabic powder had highest nutritive composition.

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