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Enhancement of Dried Fish Flavor by Cinnamon (*Cinnamon Verum*) Aqueous Extracts

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ABSTRACT

In an attempt to improve the flavor of traditional dried fish (kajeek) from Sudan, cinnamon (Cinnamon verum) aqueous extract was used. Kejeik was prepared from Mormyrus casahive (khashm elbanat), freshwater fish that obtained from Almorada fish local market, Oumdurman. The processes and analysis were done in the winter season. Cinnamon (Cinnamon verum) aqueous extract was prepared in three different concentrations (5- 10- 15%) and used during drying of the fish. The oil was extracted from the kajeek samples and the quality of dried fish was assessed after addition of cinnamon (Cinnamon verum) aqueous extract. Levels of peroxide value and acid value showed significant ($p \leq 0.05\%$) reduction after using the cinnamon as well as the pH. pH changed significantly ($p \leq 0.05\%$) to revealed the action of cinnamon (Cinnamon verum) aqueous extract in changing medium from acidic to neutral. There were insignificant ($P \geq 0.05$) differences in most of the sensory parameters of most of the dried fish samples. However, it revealed that the dried fish (kajeek) from fresh water fish (M. Casahive, khashm elbanat) from Sudan was very accepted generally, accepted as flavored with 10% cinnamon (Cinnamon verum) extract with less acceptance in color. The study revealed that cinnamon (Cinnamon verum) aqueous extract could be used in fish preservation methods as anti oxidant agent.

Keywords: *Mormyrus casahive (khashm elbanat), Kejeik, cinnamon aqueous extract, peroxide value, Acid value and pH.*

INTRODUCTION

Sudan is considered as one of the largest countries in Africa and is characterized by inland and marine fisheries resources (FAO, 2010). The total number of fish species in the Nile drainage basin, which includes the River Nile, its affluent rivers and the connected Lakes, estimated at more than 800 fish species (Omer, 2010).

Fish species are known to provide high contents of important constituents to the human diets such as readily digest able proteins, lipids, soluble vitamins, microelements and polyunsaturated fatty acids (Fagan *et al*., 2003**)**

Fish, in general, usually spoil more rapidly than other muscle foods, particularly when mishandled and due to this rapid spoilage a number of methods are used to preserve fish, such as drying and salting. Traditionally, dried fish (known as kajeek locally) represents a low cost source of high quality protein. Kajeek is consumed in many parts of Sudan as a whole food or as a sauce. Generally, fish contains a large number of microorganisms, and are the major factors contributing to the poor quality of fish in retail trade are unhygienic handling and storage leading to off-smell. Fresh whole fish are decomposed by several types of enzymatic and microbial activities.

In the stages of spoilage, the highly unsaturated fat which is especially abundant in fatty fish becomes oxidative rancid. Oxidative spoilage of fish can occur during processing as well as during storage (Van Arsdel *et al*., 1973) results in the off flavors. Rancid flavour are chemically very complex, since they are derived from any or all of the unsaturated fatty acids originally present in the oil, each of these can oxidize through several different mechanisms (Clucas and Ward, 1996).

Production and marketing of kajeek now is

retarded due to off smell and mis handling which considered as a big lost to fish nutrients. Fish processing in carried out in Sudan by traditional methods, so the amounts of the processed samples is relatively few with a short shelf life and consumed locally.

Data or researched about improve the odour of kajeek in Sudan is scarce and there is a need for such studies for paying attention to the magnitude of spoilage that occurs and required safeguards in order to cut it to the minimum within the postharvest phase. It is unfortunate that the prevalent traditional preservation methods employed throughout the country are defective and need efforts pertaining to their improvement and development. losses in products and equal in economic should be also taken inconsideration.

Cinnamon has been reported to have significant benefits for human health, mainly due to its phytochemical constituents such as phenolic and volatile compounds. The phytochemicals in cinnamon can be extracted from different parts of plant by distillation and by solvent extraction. The use of cinnamon in food and its ability to prevent oxidation and inhibit microbial growth have been reviewed (Dimas and Koen, 2017) and open a route to the use of cinnamon as an ingredient in functional foods.

MATERIALS AND METHODS

Dried cinnamon barks (*Cinnamomum verum)* were purchased from local market, Bahry, Sudan. Fish samples of *Mormyrus casahive* (khashm elbanat) used for the study were catch with the help of fisher men from Blue Nile River. Preparation of cinnamon bark aqueous extracts was done according to the method of Kim *et al*., (2014). Kejeik samples were prepared from fish *Mormyrus casahive* (khashm elbanat) according to the method described by Abdel Moneim and Waleed (2012).

Total lipids of dried fish were extracted by Blight and Dyer method (1959) method. Peroxide value, acid value and pH were determined for the fish according the method of (AOAC, 2005).

Samples of dried fish were subjected for organoleptic analysis by rating for color, flavor and general acceptability. The sensory attributes were evaluated using four scales points (very acceptable, acceptable, slightly acceptable and unacceptable).

Data were analyzed using the Software of the Statistical Analysis System (SAS, 2004). The data were subjected to analysis of variance (ANOVA). Mean separation was done using Duncan Multiple Range Test (DMRT), 1995. The significance level was set at the probability level of ($P \leq 0.05$).

Preparation of Cinnamon Aqueous Extracts

The cinnamon barks were cleaned and dried in an oven (,,,) at 50 °C until constant weight was attained; with the final moisture content being less than 5 %. The cinnamon barks were then pulverized for 3 min with a stainless steel blender (Waring Commercial, Torrington, CT, USA) followed by sieving through a sieve of mesh size 30 before being added to hot water (100 °C) each for 5-10-15g to produce 5-10-15% extracts.

The mixture was stirred using a magnetic stirrer for 15 min and filtered through Whatman No. 1 filter paper. Water was removed from filtrate under reduced pressure (Rotavapor R210, Buchi, Postfach, Flawil, Switzerland). Finally, the yield of aequous cinnamon extract was (collected) and was kept at −18 °C for further analyses.

Kejeik Preparation

Kejeik samples were prepared from freshwater fish *Mormyrus casahive* (khashm elbanat) according to the method described by Abdel Moneim and Waleed (2012). Fish samples were collected from Amorada local market (Khartoum, Sudan) during the period January-April 2019. Fresh fish were collected in sterile polyethylene bags.

The samples were then transported to the laboratory in ice boxes for preparation of kajeek. Kajeek samples were produced by natural fermentation and drying with the help of Kejeik producer. In this process the fishes were split longitudinally, gutted and beheaded, the split fish were then hung on ropes out in the open air, under the direct sun. When the drying process was over, about 85% of the water in the fish disappeared; the fishes were divided to two groups.

The first group of fishes was then dried by oven at 60°C for two days and another one week in open air under the direct sun. The large pieces of fish are flatten and pack the dry fish more compactly, further shade drying them follows after which the fish products were ready to be transported and marketed.

The Kejeik samples were collected in clean, dry

containers, and packed in sterilized plastic vacuum bags, stored in carton and kept at room temperature (25˚C). for the second groups the different cinnamon *(Cinnamon verum)* aqueous extract (5-10-15%) were added to the kajeek samples before the complete drying to produced flavored kajeek while that not flavored was used as control. the kajeek samples flavored with cinnamon *(Cinnamon verum)* were then complete the drying oven for two days at 50-60 ˚C and another one week in open air under direct sun. The samples were collected and kept for further analysis.

Chemical Analysis

Total lipids of dried fish were extracted by Blight and Dyer method (1959) method. Peroxide value, acid value and pH were determined for the kajeek samples according the method of (AOAC, 2005).

Organoleptic Analysis

The final products of the processed sample of different methods were assessed subjectively for product acceptability. The samples of dried fish were rated for colour, odour and general acceptability. Sensory attributes were evaluated using four scale points, very acceptable, acceptable, slightly acceptable and unacceptable.

Statistical Analysis

Data were analyzed using the Software of the Statistical Analysis System (SAS, 2004). The data were subjected to analysis of variance (ANOVA). Mean separation was done using Duncan Multiple Range Test (DMRT), 1995. The significance level was set at the probability level of ($P \leq 0.05$).

Results and Discussion

Table1. *pH values of Raw and Flavored kajeek of (M. Casahive, khashm elbanat) with Cinnamomun verum aqueous extract*

pH-value	Kajeek Sample
$6.50^{a} \pm 0.10$	Raw kajeek
$6.03^{b} \pm 0.06$	Flavored kajeek with 5% *Cinnamomun verum* aqueous extract
$5.63^{c} \pm 0.06$	Flavored kajeek with 10% *Cinnamomun verum* aqueous extract
$5.33^{d} \pm 0.15$	Flavored kajeek with 15% *Cinnamomun verum* aqueous extract
0.0^{**}	P-value
0.1883	$Lsd_{0.05}$

pH of Kajeek

Table 1. displayed the pH values of raw and flavored Kejeik (*M. Casahive*, khashm elbanat) with different concentrations of *Cinnamon verum* aqueous extract (5-10-15%). Results were significantly ($P \leq 0.05$) different. The pH of all kajeek (*M. Casahive*, khashm elbanat) samples was decreased with the increases in the concentration of *Cinnamon verum* aqueous extracts. The highest pH value was found among raw Kejeik (6.50^{a}) and the lowest was found among flavored Kajeek with 15% *Cinnamon verum* aqueous extract (5.33^{d}). The pH of fish flesh has an importance on its freshness because of its influence on bacterial growth. The lower the pH of fish flesh the slower the bacterial growth, however, the pH of alive fish muscle is close to value 7.0 where postmortem fish pH varies from 6.0 to 7.0 according to Pacheco Aguilar *et al* .,(2000). So according to this fact the results of table (1) is within this results. Also, it is similar to the finding of (Abbas *et al*., 2008; Abdel Moneim and Mustafa**,** 2012 and Azam and Ali, 2004). However it is lower than the finding of Ozalp and Karakaya(2009) who reported 6.28 to 7.03.

The differences in the pH values were attributed to the differences in fish species and geographical areas. Results of Table1. indicated that *Cinnamon verum* aqueous extract has a positive effect on controlling the pH of fish and fish products, so shelf life of fish and fish product could be increased through applying of cinnamon extract to fish products during preservation. Sun drying is the method used by all fish processors in Sudan. However, it is ineffective for the moisture level of the fish, is not reduced to the level that can prevent spoilage of product by microorganisms (Moy, 1977). Moreover, the humidity in tropical countries is very high. So Precaution should also be taken to maintain the level of moisture during transportation and storage of dried fish. During transport and storage, the fish should be wrapped in moisture-impermeable packaging so that it does not absorb moisture from the atmosphere. The packaging is also effective against infestation by flies. To avoid losses in

production and quality of kajeek as a result of social and economic factors**,** it is effective to introduce and improved technique for extending shelf life of kajeek (*M. Casahive*, khashm elbanat).

Reduction of the pH values of kajeek was attributed to the effect of cinnamon phytochemical composition as antimicrobial agent. Recent studies have shown that cinnamon can prevent microorganism-induced food spoilage (De La Torre *et al*., 2015). Cinnamon essential oils are ideal antimicrobial substance because they do not induce the development of antimicrobial resistance and are still effective over a long period of use (Dimas and Koen, 2017).

The potency cinnamon's antimicrobial activity has been observed in food products (Pina-Pérez *et al*., 2012; Lin *et al*., 2005; Bayoumi, 1992; Dussault *et al*., 2014; Arancibia *et al*., 2014; Tzortzakis, 2009). These authors claimed that encapsulation could guarantee protection of the antimicrobial compounds against evaporation or degradation, have various advantages for targeted site specific delivery due to high surface area to volume ratios, and allow efficient absorption through cells walls, which could lead to higher antimicrobial activation to different y.

The results of Table1. also indicated that the simplistic addition of cinnamon aqueous extracts for preservation of fish products could be done by house holders which have an economic sound as well as marketing

Drying of kajeek took one week and it needs another one week for further analysis, during this perios the ph was in the safe range without deteriorations in the products.

Change from highly acid to moderate acid no spoilage caused after using cinnamon aqueous exteract.

Table2. *Peroxide and Acid values of Raw and Flavored kajeek (M. Casahive, khashm elbanat) with Cinnamomun verum aqueous extract.*

Acid value (mg KOH/g)	Peroxide value (mEq/kg)	Kajeek Sample
0.54^{a} ±0.02	7.13^{a} ±0.15	Raw kajeek
0.39^{b} ±0.02	5.82^{b} ±0.17	Flavored kajeek with 5% *Cinnamomun verum* aqueous extract
0.29^{c} ±0.01	4.13^{c} ±0.15	Flavored kajeek with 10% *Cinnamomun verum* aqueous extract
0.20^{d} ±0.02	3.17^{d} ±0.15	Flavored kajeek with 15% *Cinnamomun verum* aqueous extract
0.0^{**}	0.0^{**}	P-value
0.00059	0.0298	$Lsd_{0.05}$

Means ± SD having different superscripts are significantly different (P≤0.05).

Peroxide and Acid Values of Raw and Flavored Kajeek (M. Casahive, Khashm Elbanat) with Cinnamon

Table (2) showed the oil characteristics (Acid value as (mg KOH/g) and peroxide value as (mEq/kg) of raw Kajeek (*M. Casahive*, khashm elbanat) and that flavored with different concentrations of *Cinnamomun verum* aqueous extract. Results were significantly (P≤0.05) different**.** Acid values of kajeek samples were ranged from 0.20^{d} ±0.02 to 0.54^{a} ±0.02, the highest acid value was recorded for the raw kajeek, dried fish while the lowest one was for that flavored with 15% *Cinnamomun verum* aqueous extract.

Peroxide value (mEq/kg) was also decreased as increase in the concentrations of cinnamon aqueous extract from 5-15%. It was ranged from 3.17^{d} ±0.15 to 7.13^{a} ±0.15.

Acid value is used as an index for measuring the quality and freshness of fish and fish products (Zaglol and Fayza, 2009). Results showed reduction of Acid values (mg KOH/g) of kajeek as increases in the concentrations of cinnamon aqueous extract from 5-15%. The acceptable range of acid values is ≤ 3 mg KOH/g according to recently published by FAO/WHO (2013). However, results of the present study were less than the limit, which mean that kajeek (*M. Casahive*, khashm elbanat) could have longer shelf life due to addition of cinnamon as antioxidant and flavor agent. Acid value of raw kajeek of (*M. Casahive*, khashm elbanat) is agreed with result of Abdulkadir *et al*., (2010).

Acceptable peroxide value is 0.0. Peroxides (R-OOH) are primary reaction products formed in

the initial stages of oxidation, and therefore give an indication of the progress of lipid oxidation

Results of Table 2. indicated that 15% aqueous extraction of cinnamon could preserve dry fish at room temperature without any changes in lipids for more than two weeks.

The progressively increased acid values during preservation might be due to hydrolytic reactions of lipids. These reactions may be related to the activity of natural lipo-protein lipases present in the tissue of fish and also to the species of bacteria present in the product which can utilize fats and intermediate fatty compounds as a source of carbon (Rodriguez *et al*., 2007). It was reported that the increase in acid value is generally associated with lipase activity originating from microorganisms or biological tissues (Memon *et al*., 2010).

Reduction of acid and peroxide values of kajeek was attributed to the effect of cinnamon as antioxidant agent which was concentration dependent (Mathew and Abraham, 2006).

The use of extracts from cinnamon that is rich in antioxidants is of increasing interest because they slow the oxidative degradation of lipids and improve the quality and nutritional value of food (Hashemi *et al*., 2016). In food, the potential antioxidant activity of cinnamon and its derivatives and its ability to improve the shelf lives of foods have been widely reported (Özcan and Arslan, 2011; Cheng *et al*., 2013).

The use of cinnamon in extending the shelf lives of foods can be carried out not only by adding the cinnamon directly to the food matrix but also by incorporating the cinnamon into the packaging material (Dimas and Koen, 2017). This approach can minimalize the drawbacks to the use of cinnamon on sensory properties of the food since the cinnamon odor may damage the original flavor of the food. In a study by (Hu *et al* ., 2015) peroxide values and 2-thiobarbituric acid values were significantly decreased after using cinnamon essential oil incorporated directly into the low density polyethylene film as antioxidant in pork.

it was shown that low-density polyethylene film with encapsulated cinnamon essential oil incorporated directly into the film exhibited excellent antioxidant activity in pork with a very low intensity of cinnamon odor in the product, low enough that it was still acceptable to consumers. In their investigation, the treated samples had significantly lower peroxide values and 2-thiobarbituric acid values than non-treated samples. This study indicated that the incorporation of cinnamon into packaging material is strategically feasible for extending the shelf life of food with minimum impact on their sensory properties.

Phenolic and volatile compounds in cinnamon play significant roles in the antioxidant activity (Bacanl. 2015; Babu *et al*., 2007; Khare *et al*., 2014).

SHELF LIFE COULD BE INCREASED STUDIES ON THE EFFECT OF STORAGE ON FLAVOURES KAJEEK…GOOD SUITABLE PACKAGING, microbiological studies (recommendations)

Table3. *Sensory evaluation of raw and flavored kajeek (M. Casahive, khashm elbanat) with Cinnamomun verum aqueous extract*

General acceptability	**Flavour**	**Color**	**Kajeek Sample**
Scores			
$3.00^{a} \pm 1.18$	$2.50^{b} \pm 1.16$	$3.43^{a} \pm 1.22$	**Raw kajeek**
$3.43^{a} \pm 1.16$	$2.86^{ab} \pm 1.35$	$3.29^{a} \pm 1.14$	**Flavored kajeek with 5%** *Cinnamomun verum* **aqueous extract**
$2.93^{a} \pm 1.21$	$3.79^{ab} \pm 1.05$	$3.14^{a} \pm 1.35$	**Flavored kajeek with 10%** *Cinnamomun verum* **aqueous extract**
$2.50^{a} \pm 1.29$	$3.00^{a} \pm 1.11$	$3.21^{a} \pm 1.19$	**Flavored kajeek with 15%** *Cinnamomun verum* **aqueous extract**
0.257^{NS}	0.039^{*}	$>0.05^{NS}$	**P-value**
0.9161	0.8897	0.931	**Lsd$_{0.05}$**

Means ±SD having different superscripts are significantly different (P≤0.05).

Table (3) illustrated the preferences of the panelist for color, flavor and general acceptability for the raw and flavored kajeek with different concentrations of cinnamon *(Cinnamon verum)* aqueous extract. The results show that there were insignificant (P≥0.05)

differences in most of the sensory parameters of most of the dried fish samples. For the colour, there was insignificant variation. regardless the significances, raw kajeek was mostly preferred compared to that with cinnamon flavored kajeek followed by 5% and 15% kajeek with cinnamon*(Cinnamon verum)* aqueous extract . It is clear that the consumers prefer the natural color of the fish and their products. Though it is recommended to use colorless flavor agents. Extract the colour of the cinnamon and then could used for

In the quality assessment of fresh fish the sensory evaluation is most important. As quality deterioration progresses, several off-odours can be noticed. Many different odors compounds can be perceived but some are having very low odour threshold values.

The sensory evaluation results of the dried fish samples are shown in Table (3). The results show that there were insignificant ($P \geq 0.05$) differences in most of the sensory parameters of most of the dried fish samples. However, significant ($P \leq 0.05$) differences were recorded in flavor of dried fish products (kajeek) prepared from (*M. Casahive*, khashm elbanat). The panelists gave high scores for flavored kajeek with 15% cinnamon aqueous extract, and the other dried fish products were not highly prefered by the panelists. However, dried fish without flavor (*M. Casahive*, khashm elbanat) was given the lowest scores for flavor, while given the highest scores of color.

For general acceptability there was insignificant ($P \geq 0.05$) result for different kajeek samples, the raw kajeek has the lowest score for acceptance and the highest one was given for kajeek with 10% cinnamon aqueous extract. This study revealed that sensory evaluation for dried fish (kajeek) from fresh water fish flavor (*M. Casahive*, khashm elbanat) from Sudan was very accepted generally, accepted as flavored with 10% cinnamon extract with less acceptance in color.

Considering the odor characteristics of the volatile components of the cinnamon essential oils, the presence of the essential oils on the surface of the capsules may affect the sensory characteristics of enriched foods. Organoleptic effects should be taken into consideration by any researchers investigating the applications of cinnamon in food matrices as antimicrobial agents. In this regard, some scientists have developed a new active packaging material for encapsulating cinnamon (Rodriguez *et al*., 2008). By this method, direct contact between cinnamon and food can be avoided, and as a result, the drawbacks of the use of cinnamon as an antimicrobial agent on the sensory properties of foods can be minimalized. However, it is important to note that the inhibitory effects of essential oils against microorganisms may be different between the two modes of treatment (exposure by vapor or by direct contact).

Conclusion

In attempts targeting flavor improvement of dried fish (kajeek) in Sudan, cinnamon aequous extract was used in order to use the products for consumption at subsequent times and places far away from the source.

This programme is also was arranged for a that there is a need to evaluate traditional and improved methods of preservation of dried fish to reach an acceptable product for the consumer. the results revealed that using cinnamon aquous extrat for improving flavor is attained but It is clear that the consumers prefer the natural color of the fish and their products. Though it is recommended to use colorless flavor agents.

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