Meat Research
Vol 4, Issue 3: 1-5, Article 96, June 2024
ISSN: 2790-1971
https://doi.org/10.55002/mr.4.3.96 http://www.bmsa.info/meatresearch

[1]Animal Production Research Division, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh
[2]Office of Director Research, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh
[3]Goat Production Research Division, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh

***Corresponding author:**

BK Roy
E-mail: biplobkumerroy@gmail.com

Keywords:

Kalojira oil
NaCl
$NaNO_2$
Preservatives

Article Info:

Received: 15 May, 2024
Accepted: 14 June, 2024
Published online: 30 June, 2024

Research Article

Production and preservation quality assessment of canned beef

BK Roy[1*], N Sultana[2], JS Khanam[3], SA Tule[1]

Abstract

The present study was undertaken to produce canned beef along with the determination of its preservation quality. Kalojira oil (*Nigella sativa*), Na-nitrite ($NaNO_2$) and common salt (NaCl) were added in beef and treated as preservative groups namely T_1, T_2 and T_3 treatment group respectively. Beef without addition of any preservative kept as control group (T_0) and each group or treatment containing three (03) replications. Data from both fresh raw beef and canned beef were compared statistically in an ANOVA of a Completely Randomized Design using General Linier Model Procedures of SPSS, 20 computer software packages. Beef was purchased from local market immediate after slaughter and brought at meat processing laboratory of BLRI. The physicochemical properties and microbiological properties of both raw beef and canned beef were recorded. The physical properties viz, pH, drip and cook loss of fresh raw beef were 6.40, 5.55% and 27.71%, respectively. The moisture and CP content in raw beef were 74.61 and 25.39%, respectively. The total viable bacteria count and Coliform count in raw beef were 8.8×10^6 and 4.3×10^4 cfu/g, respectively. The pH of canned beef was higher ($p < 0.05$) in meat preserved with $NaNO_2$ and Kalojira oil than that of NaCl and control group. Preservatives, however, had no effects ($p > 0.05$) on moisture or DM and CP content in canned beef. Though, there was no significant ($p > 0.05$) effect, but Kalojira oil performed as impressive preservative compared to others. In microbiological aspects of canned meat, the TVC, TCC, *Salmonella spp*. and *Staphylococcus spp*. were entirely absent in Kalojira group. In case of $NaNO_2$ and NaCl group, only a very few numbers of viable bacteria were found (1×10^2). On the other hand, only the Staphylococcus bacteria were found in case of control group. Considering the physico-chemical and microbiological aspects in canned beef, it may be concluded that the Kalojira oil could be a suitable value-added preservative in meat canning.

Introduction

Now people irrespective of gender are working outside of home and they have no time for cooking like our traditional system and most of them are dependent on processed food. But in our country aspect, there are a very few numbers of branded beef processed product item which are available only in capital or big cities and no processing system of raw meat has yet been developed. So, development of meat value addition technique at industrial level has huge opportunity which will satisfy consumers demand and contribute to national economy. This will also satisfy the globally emphasized food safety issue too. So, it is high time to diversify the traditional production system and introduce value addition system of products and by-products. Many options like deboning, size reduction, seasoning, tenderization, smoking, battering, canning, marinating etc. are globally accepted to add value to meat of which meat canning technique is getting popularity day by day. Canning is an international popular food preservation technique which involves processing and sealing of food products in air tight container which improves the shelf life, preservation quality and saves the cooking time of consumers. In recent years, the growing need for food safety has prompted study into the risks associated with consuming contaminated (by pesticides, heavy metals, and toxins) foods (Al-Azzawi et al., 2014). As a result of these factors, it has become very necessary to preserve the nutritional value and freshness of meat and meat products by using a variety of variables (holding time, temperature, and light intensity during storage, humidity, atmospheric oxygen level, enzymes, microorganisms etc.) (Pressman et al., 2017). In addition to the fermentation method, salt has been widely used in food preservation in general and meat in particular. Salt is still one of the most common food preservatives as it helps to reduce the growth of microorganisms by providing environment that is not suitable for the growth of these microorganisms (Akter et al., 2009; Rahman et al., 2007and 2023). Nitrides and nitrates are known to be multifunctional food additives and powerful antioxidants as they are used in many foods and in the treatment of meat as preservatives (Long et al., 2011). Edible oil also used as meat preservatives in short time meat preservation (Das et al., 2022; Fratianni et al., 2010). Black cumin (*Nigella sativa*) seeds exhibit antioxidant, antimicrobial, anti-inflammatory, and anticancer properties, making them biologically active (Eskandari et al., 2014). Essential oils extracted from black cumin seeds known as Kalojira oil have been used as spices, preservatives and also as Nutraceuticals and functional foods. Kalojira oil is such a potential source of natural antioxidant and been reported to be a source of thyroquinone, carvacrol, t-anethole and 4-terpineol, flavonoids, phenolics, alkaloids, unsaturated fatty acids etc which acts as good preservatives. From this aspect,

the present study was undertaken to determine the effect of Kalojira oil (Fennel flower; *Nigella sativa*), Na-nitrite ($NaNO_2$) and common salt (NaCl) on the preservation quality of canned beef.

Materials and methods

Sampling

Raw meat (beef) was purchased from local market immediate after slaughter and brought at meat processing laboratory of BLRI. Then beef was sliced with a knife (German, Stainless steel, 11290-170, 6.5˝).

pH

At about 6 hours of postmortem both raw beef and canned beef pH were recorded with a digital pH meter (Hanna; model no. HI2211-02) following the method of University of Nebraska-Lincoln (2005).

Proximate composition

Both fresh beef and canned beef at 30 days aged samples were collected for proximate analysis. The proximate composition of both fresh and canned beef was determined by the method described by Association of Official Analytical Chemist (AOAC, 2005).

Drip loss measurements

Drip losses of fresh beef samples were estimated according to the procedures by Joo et al. (1995).

$$\text{Drip loss (\%)} = [(\text{sample weight} - \text{sample weight after 24 h})/\text{sample weight}] \times 100$$

Cooking loss measurements

Cooking losses of fresh beef samples were estimated 24 hours post mortem according to the procedures recommended by Yang et al. (2006).

$$\text{Cooking loss (\%)} = [(A-B)/(A)] \times 100$$

Where, A is weight of raw meat samples before cooking and B is the cooled post-cook weight of the samples.

Microbiological test

Total Viable Count (TVC), Total Coliform Count (TCC), presence or absence of *Salmonella spp.* and *Staphylococcus spp*. in both raw (fresh meat) and canned meat were done at Food Safety Laboratory in BLRI.

Sample preparation

One gram (1g) of the beef sample was weighed and aseptically taken into a sterile jar containing 9ml of sterile normal saline diluent. It was homogenized for 15 seconds and a 1 ml homogenate was transferred to a test tube containing 9 ml -1 sterile distilled water to make 10 dilution and -4 well mixed. Serial dilutions up to 10 were prepared for the microbiological analysis (Fawole and Oso, 2001). Then 1ml of sterile culture media was poured into each sterile petri dish, distributed and mixed evenly throughout. The petri dishes with molten inoculated media were allowed to solidify. All samples inoculated in nutrient agar were incubated at 37ºC for 24 hours to get (TVC) while samples inoculated in Mac Conkey agar were incubated at 37ºC and 44ºC for 24 hours for Total Coliform Count (TCC) and Potato dextrose agar for Total Fungal Count (TFC) counts respectively (Bhandare et al., 2009).

Total Viable Count (TVC)

Total Viable Counts were isolated and enumerated by pour plate method and grown on Nutrient Agar (NA). Serial dilutions of up -4 to 10 were prepared by diluting 1g of the sample into 9 ml of sterilized distilled water. One milliliter (1ml) aliquots from each of the dilutions were inoculated into Petri dishes with already prepared NA. The contents were swirled gently to thoroughly mix the agar with the inoculums. The plates were then inverted and incubated at 37^0C for 24 hours. After incubation all white spot or spread were counted and recorded as total viable count.

Total Coliform Count (TCC)

Total Coliform Counts were isolated and enumerated by pour plate method and grown on Mac Conkey Agar (MCA). Serial dilutions -4 of up to 10 were prepared by diluting 1g of the sample into 9 ml of sterilized distilled water. One milliliter (1ml) aliquots from each of the dilutions were inoculated into petri dishes with already prepared MCA. The contents were thoroughly mixed. The plates were then inverted and incubated at 37^0C for 24 hours.

Enumeration of Staphylococcus species

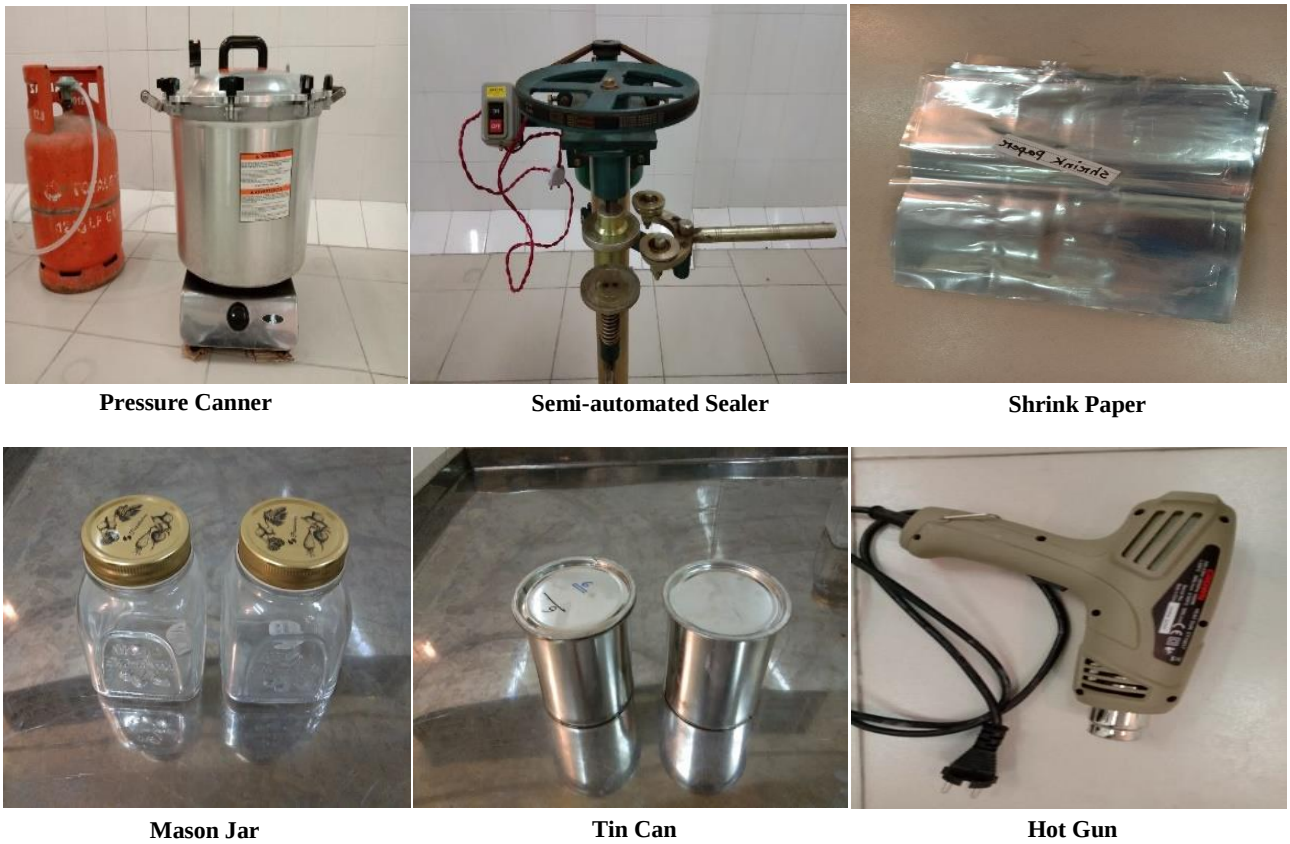
Staphylococcus species were isolated and enumerated by pour plate method and grown on Salt Mannitol Agar (SMA). Serial -4 dilutions of 10-1 to 10 were prepared by diluting 1g of sample into 9 ml of sterilized distilled water. One milliliter aliquot from each of the dilution were inoculated into Petri dishes with already prepared SMA. The inoculum was evenly spread and allowed to dry for 15 minutes at room temperature. The plates were inverted and incubated at 37 ºC for 24 hours. After incubation yellow colonies were counted and recorded as Staphylococcus counts.

Enumeration of Salmonella species

Prepared 10 ml of manufactured formula of Buffered peptone water (BPW), Oxoid CM009 (containing peptone 10.0; sodium chloride 5.0; pH 7.2 ± 0.2 at 25 ºC) was in a universal bottle and serial dilution of samples added to it. It was incubated at 37 ºC for 24 hours. Then 0.1 ml of the sample from the BPW was placed in a 10 ml of serenite broth in universal bottle and incubated at 44 ºC for 48 hours. Salmonella- Shigella agar (SSA) was added and incubated for 48 hours at 37ºC. Cream colonies with black centers on the SS agar indicated the presence of Salmonella.

Production of canned beef

Each jar was filled with about 470 g fresh sliced beef where Kalojira (Fennel flower; *Nigella sativa*) oil, Na-nitrite ($NaNO_2$) and common salt (NaCl) were added and treated as T_1, T_2 and T_3 treatment group. However, raw beef without added any preservative kept as control group (T_0). The level of using Kalojira oil, Na-nitrite ($NaNO_2$) and common salt (NaCl) were 10.00 ml, 150.00 mg and 5.00 g respectively for per kg of fresh raw beef. The Number of replications in each treatment groups including control were nine (09). Immediate after filling the meat into glass jar (Product dimension: Height-115 mm, Diameter-85 mm, Volume-500 ml, Length-85 mm; Made in China) preservatives were incorporated in glass jars. Then the self-sealing screw cap jar lid were sealed tightly. The canner machine was prepared by applying moisturizer on both sides and filled with water up to 2-3 inch from bottom. Then it was placed on cooking burner until boiling of water. When boiling was started the vapor was removed and glass jars were placed in pressure canner machine. Canning was performed at 240° F under10 lb pressures for 75 minutes. After removing glass jars from pressure canner machine, all the jars were checked properly for any leakage. Finally, the lids of all the jars were again sealed with shrink paper using an electric hot gun. However, all the jars were kept under ambient room temperature for a period of 30 days.



Pressure Canner | **Semi-automated Sealer** | **Shrink Paper**

Mason Jar | **Tin Can** | **Hot Gun**

Figure 1. Basic requirements for canning meat.

Final recovery rate calculation

After 30 days, the canned beef from the glass jar was poured into a sieve for 10-15 minutes to remove water completely. The extracted water amount and beef wt. after water extraction was recorded for final recovery rate calculation.

Statistical analysis

Data on physical, chemical and recovery rate of both raw beef and canned beef were compared statistically in an ANOVA of a Completely Randomized Design (CRD) using General Linier Model Procedures (GLMP) of SPSS, 2000 computer software packages.

Results and discussion

Table 1. Physical, chemical and microbiological properties of fresh beef

Physical properties	
Meat pH	6.40
Drip loss (%)	5.55
Cook loss (%)	27.71
Chemical properties	
Moisture, %	74.61
Dry matter, % fresh	25.39
Crude protein, % fresh	19.36
Fat, %	-
Organic matter, %	95.88
Ash	4.12
Microbiological properties	
TVC (cfu/g)	8.8×10^6
TCC (cfu/g)	4.3×10^4
Salmonella spp.	Nil
Staphylococcus spp.	Present

The physical, chemical and microbiological properties of fresh raw beef used for canning purpose is presented in Table 1. It shows that the physical properties (pH, drip and cook loss) of fresh raw beef were 6.40, 5.55% and 27.71%, respectively. Drip loss and cooking loss is very important for palatability, juiciness, and thus the overall quality and acceptability of meat. High drip loss in fresh meat indicates poor quality meat. Cooking loss indicates the ability of meat to retain its water after heating. The moisture content and crude protein content in raw beef were 74.61 and 25.39%, respectively. Monitoring presence of microorganisms and its level in meat is an important step in good management practice of butcheries and beef value chain (Poumeyrol et al., 2010). Potential safety and quality in raw meat products can be estimated with the use of indicator microorganisms including aerobic plate count, coliform count, E. coli count (Kim and Yim, 2016). Coliform count provides an estimation of fecal contamination and poor sanitation during the processing of raw beef (Al-Mutairi, 2011). The total viable bacteria count and Coliform count in fresh raw beef however, were 8.8×10^6 and 4.3×10^4 cfu/g (Table 1), respectively. High Coliform count generally correlates with higher levels of foodborne pathogens of fecal origin (Milios et al., 2014). This quality deterioration of market raw beef was due to the slaughtering system of our country which exceed the accepted range (> 5.0 log cfu/g for TVC and < 3.0 log cfu/g for TCC, according to FAO, 2007) and raw meat used in this study were collected from local market, so this could be the reason behind it.

Table 2. Effect of preservatives on physico-chemical, microbiological properties of canned beef

Parameters	Treatments				SED	Sig.
	T_0	T_1	T_2	T_3		
Physico-chemical properties						
P^H	6.47^{bc}	6.48^{bc}	6.55^{ac}	6.38^{b}	0.02	*
Moisture, %	63.36	59.21	63.31	61.96	1.11	NS
Dry matter, %	36.64	40.79	36.69	38.04	1.11	NS
Organic matter, %	97.03^{bc}	97.06^{bc}	97.34^{ac}	96.41^{b}	0.15	*
Crude Protein, %	28.31	28.99	28.54	28.57	0.24	NS
Total mineral, %	2.97	2.94	2.67	3.59	0.15	*
Loss or recovery rate						
Losses during canning process, %	3.83	2.13	6.70	6.28	1.26	NS
Water in canned jar, %	30.85	28.30	28.72	27.55	0.80	NS
Meat in canned jar, %	62.76	64.36	62.23	63.08	2.00	NS
Microbiological properties						
TVC (cfu/g)	Nil	Nil	1×10^2	1×10^2	-	-
TCC (cfu/g)	Nil	Nil	Nil	Nil	-	-
Salmonella spp.	Nil	Nil	Nil	Nil	-	-
Staphylococcus spp.	Present	Nil	Nil	Nil	-	-
Cost of production (One kg canned beef)	714	724	714	714	-	-

The effect of preservatives on physico-chemical, microbiological properties and recovery rate of canned meat is presented in Table 2. It shows that, the pH of canned beef was significantly ($p<0.05$) higher in meat preserved with $NaNO_2$ and Kalojira oil than that of NaCl and control group. Preservatives, however, had no effects ($p>0.05$) on moisture or DM and CP content in canned beef. Similarly, the losses during canning process or recovery rate after 30 days of canning did not vary significantly ($p>0.05$) among the preservatives groups. Though, there was no significant ($p>0.05$) effect, but Kalojira oil performed as impressive preservative compared to others. The maximum DM (40.79%) and CP (28.99%) content was found in Kalojira oil which becomes proven in having maximum recovery rate (64.36%) and lowest loosing rate (2.13%) during the canning processes. The highest mineral content (3.59%) was in common salt (NaCl) group as because common salt itself is a mineral so it decreased the total organic matter (96.4%) and increased the total mineral content as well. In microbiological aspects of canned meat, the TVC, TCC, *Salmonella spp*. and *Staphylococcus spp*. were entirely absent in Kalojira group. In case of $NaNO_2$ and NaCl group, only a very few numbers of viable bacteria were found (1×10^2). On the other hand, only the Staphylococcus bacteria were found in case of control group.

Moreover, it was estimated that the production cost of one (01) Kg canned beef using preservatives and without preservatives were Tk. 714, Tk. 724, Tk. 714 and Tk. 714, respectively for control, Kalojira oil, Sodium nitrite and Sodium chloride as preservatives (Table 2).

Conclusions

Considering the physico-chemical and microbiological aspects in canned beef, it may be concluded that the Kalojira oil could be a suitable value-added preservative in meat canning compare to NaCl and $NaNO_2$ the two recognized preservatives; may be for its own herbal or medicinal properties.

Acknowledgements

We acknowledge to all those who had helped for successful completion of the research.

Conflicts of interest

The author(s) declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Akter H, S Akhter, SME Rahman, MM Rahman, MM Hossain, CS Ra, JM Kim and DH Oh. 2009. Effect of different preservation methods on physicochemical qualities of beef. Journal of Food Hygiene and Safety, 24 (3): 217-225.

Al-Azzawi MN, Al-Ani LH. 2014. Determination of heavy metals in imported canned fish that sold in Baghdad markets. Iraqi Journal of Science, 55: 675-684.

Al-Mutairi MF. 2011. The incidence of Enterobacteriaceae causing food poisoning in some meat products. Advance Journal of Food Science and Technology, 3: 116–121.

AOAC. 2005. Official Methods of Analysis, Centennial Edition. Association of Official Analytical Chemist, Washington DC.

Bhandare SG, Paturkar AM, Waskar VS and Zende RJ. 2009. Bacteriological screening of environmental sources of contamination in an abattoir and the meat shops in Mumbai, India. Asian Journal Food Ag-Industry, 2 (3): 280-290.

Das A, Hashem MA, Azad MAK, Rahman MM. 2022. Edible oil marination in broiler meat for short term preservation. Meat Research, 2: 3, Article 22. https://doi.org/10.55002/mr.2.3.22

Eskandari S, Hosseini H, Gholamzadeh M, Mousavi KA, Hosseini E. 2014. The effect of black Cumin, black caraway extracts and their combination on shelf-life extension of silver carp (Hypophthalmichthys molitrix) during refrigerated storage. Journal of Food Safety, 35(2): 154-160.

FAO 2007. Meat processing technology for small–to-medium-scale producers. Gunter Heinz and Peter Hautzinger, RAP Publication, pp 339-379.

Fawole MO, Oso BA. 2001. Laboratory manual of Microbiology: Revised edition spectrum books Ltd, Ibadan. Page 127.

Fratianni FL, Martino D, Melone A, Feo VD, Coppola R, Nazzaro F. 2010. Preservation of chicken breast meat treated with thyme and balm essential oils. Journal of Food Science, 75: 528–535.

Joo ST, Kim BC, Kim CJ. 1995. The relationship between color and water-holding capacity in post-rigor *porcine longissimus* muscle. Journal of Muscle Foods, 6: 200-226.

Kim J, Yim DG. 2016. Assessment of the microbial level for livestock products in retail meat shops implementing HACCP system. Korean Journal of Food Science in Animal Resources, 36(5): 588-594.

Long NBS, Gal R, Bunka F. 2011. Use of phosphates in meat products. African Journal of Biotechnology, 10: 19874-19882.

Milios KT, Drosinos EH, Zoiopoulos PE. 2014. Food Safety Management System validation and verification in meat industry: Carcass sampling methods for microbiological hygiene criteria–A review. Food Control, 43:74–81.

Poumeyrol G, Rosset P, Noel V, Morelli E. 2010. HACCP methodology implementation of meat pâté hazard analysis in pork butchery. Food Control, 21:1500–1506.

Pressman P, Clemens R, Hayes W, Reddy C. 2017. Food additive safety: A review of toxicologic and regulatory issues. Toxicology Research and Application, 1:1-22.

Rahman MM, Hashem MA, Azad MAK, Choudhury MSH, Bhuiyan MKJ. 2023. Techniques of meat preservation-A review. Meat Research. 3 (3): Article No. 55.

Rahman MS. 2007. Handbook of food preservation. CRC press.

SPSS. 2000. Statistical Package for Social Science. Copyright (e) SPSS Inc. USA.

University of Nebraska- Lincoln: Fact Book, 2005-2006

Yang HS, Moon SS, Jeong JY, Choi SG, Joo ST, Park GB. 2006. Effect of sodium bicarbonate injection in pre-rigor porcine *M. Longissimus lumborum* on pork quality. Asian-Australian Journal of Animal Sciences, 19: 898-904.