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Research Article

PHYSICO-CHEMICAL PROPERTIES OF SHELF STABLE MEAT PICKLE FROM KADAKNATH

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ABSTRACT

The Kadaknath meat pickle was prepared involving cooking variation and dehydration to develop product with enhanced shelf stability and appreciable physico-chemical properties. Four variants of product were prepared; T1 (steam cooked), T2 (microwave cooked), T3 (steam cooked and dehydrated) and T4 (microwave cooked and dehydrated). The product yield, water activity (aw) and proximate composition revealed that dehydrated variants (T3 and T4) had better physico-chemical properties than non-dehydrated (T1 and T2). Storage study revealed significant ($p \leq 0.05$) decrease in pH from day 0-100 in all the four treatments, however pH of T3 and T4 (dehydrated variants) was lower as compared to T1 and T2. On the other hand, the dehydrated variants (T3 and T4) had higher free fatty acid (FFA) and titrable acidity (TA) than T1 and T2. Similarly, T3 and T4 had higher values as compared to T1 and T2 for thio-barbituric acid (TBA), however the TBA values in pickles were well within the prescribed limit for acceptable products. A significant ($p \leq 0.05$) increase in TA, FFA as well as TBA value with the increase in storage period of meat pickle was also observed. The T3 and T4 variants of product were found to have higher product yield, protein and fat content with significantly ($p \leq 0.05$) lower moisture level and water activity than non dehydrated product (T1 and T2). Further, the lower pH and higher titrable acidity indicated enhanced shelf stability for the dehydrated variants (T3 and T4) of the product. Overall the T3 product was found to have better features than others.

Keywords: Dehydration, Kadaknath, Meat, Pickle

Kadaknath is a poultry breed, being reared by native tribal population of Western Madhya Pradesh, India. It has a delicious flavor and is considered rich source of protein and iron. The lack of facility for proper storage and processing in the country is biggest hurdle in popularization of Kadaknath based meat and meat products to greater masses.

Pickling is an ancient form of food preservation with evidences to suggest that it was followed by our ancestors. However, the shelf-stability of meat based pickle is comparatively less than what we get in the high acid food based pickles like mango, lemon etc. The practice in vogue for meat pickle preparation does not involve the drying/ dehydration technique, which is commonly used for vegetable/raw fruit based pickling. Drying is one of the oldest methods of food preservation and processing (Vadivambal and Jayas, 2007) where water is removed from a material by evaporation or sublimation. The dehydration process leads to lowering of water activity (aw) which results in control of microbial activity and hence the enhancement of product shelf stability. As present practices of meat pickling involve application of synthetic chemicals as preservative and they have been found to be associated with ill health effect, dehydration and cooking were applied in the present study to have a product with enhanced shelf stability. The present study was planned to explore the physico-chemical changes in meat pickle prepared after cooking and/or dehydration of Kadakhnath meat.

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MATERIALS AND METHODS

Meat and additives: Kadaknath birds of same age were obtained from the poultry farm of College of Veterinary Science and Animal Husbandry, Rewa. Birds were slaughtered and dressed as per the standard procedure in the department. The dressed carcasses obtained were kept at 4±1 ºC for 24 hours, after packing in low density polyethylene (LDPE) bags. Later the meat was portioned after removing separable fat and connective tissue and kept in LDPE bags at freezing temperature of -18±1 ºC till further studies. Various condiments (ginger and garlic),

Table 1

Composition of spice mix

S.No.	Name of ingredients	Percentage (w/w)
1.	Bay Leaves (Tejpatta)	03.00
2.	Black pepper (Kali mirch)	10.00
3.	Cardamom dry (Chhoti Elaichi)	12.00
4.	Cinnamon (Dalchini)	05.00
5.	Cloves (Laung)	02.00
6.	Coriander (Dhania)	20.00
7.	Cumin seeds (Jeera)	16.00
8.	Dry ginger powder (Soanth)	05.00
9.	Fennel (Saunf)	03.00
10.	Long Pepper (Pipali)	03.00
11.	Mace (Javitri)	03.00
12.	Nutmeg (Jaifal)	03.00
13.	Red Chilli (Lal Mirch)	15.00
	Total	100.00

mustard oil, salt, vinegar, spices were purchased from local market. The spice mix was prepared as per the composition given in Table 1. All the chemicals and media used in the study were of analytical grade and obtained from reputed firms.

Packing material: Low density polyethylene pouches and glass jars were procured from local market and used for storage of products and other materials.

Product processing: The meat was cut into pieces of about 1.0 inch in size after proper thawing. These cut pieces were washed properly and cooked by two methods i.e. steam and microwave for 20 and 7 minutes, respectively, where the time of cooking was standardized following different trials. The cooked meat from both methods was utilized for pickle preparation, where one batch from each cooking method was immediately processed for pickling for the treatment T1 and T2, respectively and another batch from each cooking lot was subjected to dehydration in hot air oven. The dehydration was performed as per the modified method adopted from Mishra *et al.* (2017) where temperature of 70±2 ºC was maintained in hot air oven for steam and microwave cooked meat pieces for 4 and 3 hours, respectively, as per the standardization trials to get the moisture well below 50%. The dehydrated meat pieces were used to prepare the pickle for T3 and T4 variants. Hence, total four types of products were prepared for the study involving minimum six replicates.

The pickle was prepared following a modified method of Chellaram *et al.* (2014). Ginger and garlic were grounded into fine paste along with little vinegar to prepare condiments. For preparation of meat pickle, 2/3rd of total mustard oil was used to fry the condiments and spices (Table 2). The cooked/cooked and dehydrated meat pieces were added and fried followed by addition of salt and citric acid. The content was heated till boiling occurred. Vinegar was added to pickle after cooling the boiled content and finally transferring it to glass jar followed by addition of remaining oil to cover the pickle.

Table 2

Pickle formulation

S.No.	Ingredient	Percentage of meat	Weight basis (w/w)
1.	Kadaknath meat	-	1000
2.	Mustard oil	60	600
3.	Vinegar	20	200
4.	Spice mix	4	40
5.	Salt	4	40
6.	Condiments	20	200
7.	Citric acid	0.5	5
8.	Mustard seed	3	30
	Total	-	2115

Physicochemical analysis: All the four type of pickles were analyzed for physico-chemical parameters such as cooking yield, dehydration yield and product yield on per cent basis, water activity (aw) (by water activity meter), proximate composition (AOAC, 2005). The pH was estimated as per the procedure given by Trout *et al.* (1992). TBA value was estimated following the method described by Witte *et al.* (1970). Titrable acidity and free fatty acids were determined as given by Shelf and Jay, 1970 and Koniecko, 1979, respectively.

Statistical analysis: Data were analyzed statistically on 'SPSS-20.0' (SPSS Inc., Chicago, II USA) software package as per the standard method of analysis (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Studies on fresh products

Cooking, dehydration and product yield: The cooking yield differed significantly for different methods of cooking (p=0.05). The yield with steam cooking method was 90.21%, whereas, microwave cooking yielded 84.57%. The lower yield in microwave cooking might have occurred due to excessive moisture loss in comparison to the steam cooking where moist heat was involved. The results were in agreement with the findings of Yarmand and Homayouni (2009), where they observed that microwave cooking got higher losses than the conventional methods of cooking. Similarly, the yield observed for steaming+ dehydration was 87.56 % which was significantly (p=0.05) lower than that of microwave+dehydration where the yield was 92.52 % (Table 3). The higher yield in microwave cooking might have been due to less moisture loss, as there was already more loss during cooking and also the hardening of surface of meat pieces could be the another reason.

Water activity (aw): Water activity (aw) of products (Table 3) prepared without dehydration (T1 and T2) and that of products prepared involving dehydration (T3 and T4) differed significantly (p=0.05). It has been observed that shelf stable foods known as intermediate moisture foods contain moisture between 15%-50% and aw between 0.60-0.85 (Jay *et al.*, 2005). The T2 and T3 products had moistures and aw within the above said range to be considered as shelf stable meat products, however the aw observed for fresh meat pickles prepared without dehydration was in agreement to the findings of Hafiz *et al.* (2013).

Proximate composition: The analysis revealed that moisture content in four variants of product i.e. T1, T2, T3 and T4 was 58.86, 55.70, 39.40 and 41.46 per cent, respectively, and there was significant (p=0.05) difference

Table 3

Yield (%) and water activity (aw) values of Kadaknath meat pickle (Mean±SD; n=6)

S.No.	Treatment	Cooking yield	Dehydration yield	Product yield	Water activity (aw)
1.	T1	$90.21^{b} \pm 2.35$	-	$92.79^{a} \pm 1.56$	$0.94^{b} \pm 0.02$
2.	T2	$84.57^{a} \pm 3.78$	-	$93.88^{ab} \pm 2.47$	$0.93^{b} \pm 0.01$
3.	T3	-	$87.56^{a} \pm 0.97$	$95.68^{b} \pm 1.37$	$0.85^{a} \pm 0.02$
4.	T4	-	$92.52^{b} \pm 1.48$	$94.56^{ab} \pm 2.09$	$0.84^{a} \pm 0.02$

a,b- Means with different superscripts in a column differ significantly at $p \leq 0.05$. T1: Steam cooked, T2: Microwave cooked, T3: Steam cooked+ Dehydrated, T4: Microwave cooked+ Dehydrated

Table 4

Proximate composition (%) of Kadaknath meat pickle (Mean±SD; n=6)

S.No.	Treatment	Moisture	Protein	Fat	Ash
1.	T1	$58.86^{d} \pm 0.91$	$25.89^{a} \pm 0.68$	$9.82^{a} \pm 0.72$	$3.03^{a} \pm 0.49$
2.	T2	$55.70^{c} \pm 0.51$	$27.70^{b} \pm 0.73$	$10.92^{b} \pm 0.20$	$3.52^{ab} \pm 0.77$
3.	T3	$39.40^{a} \pm 1.17$	$34.01^{d} \pm 1.09$	$16.15^{d} \pm 0.16$	$4.08^{b} \pm 0.60$
4.	T4	$41.46^{b} \pm 0.86$	$32.34^{c} \pm 1.16$	$14.97^{c} \pm 0.24$	$4.18^{b} \pm 0.46$

a,b - Means with different superscripts in a column differ significantly at $p \leq 0.05$. T1: Steam cooked, T2: Microwave cooked, T3: Steam cooked+ Dehydrated, T4: Microwave cooked+ Dehydrated

between them (Table 4). The results observed for moisture content of pickle prepared without dehydration are in agreement with the findings of Gadekar *et al.* (2008) and Das *et al.* (2013). However, moisture content observed for dehydrated meat pickle i.e. T3 and T4 are in agreement with Kharb and Ahlawat (2010).

Protein content of T1, T2, T3 and T4 was 25.89, 27.70, 34.01 and 32.34, respectively, with significant (p=0.05) difference among them (Table 4). Highest protein content of 34.01% was observed in T3 (steam cooking + dehydration). The protein content observed for non-dehydrated meat pickles is agreement to the findings of

Table 5

Physico-chemical properties of Kadaknath meat pickle during storage (Mean±SD; n=6)

Treatment	Storage days					
	0	20	40	60	80	100
			pH			
T1	$5.92^{Fb} \pm 0.06$	$5.72^{Eb} \pm 0.05$	$5.47^{Db} \pm 0.08$	$5.16^{Cbc} \pm 0.04$	$4.92^{Bc} \pm 0.04$	$4.74^{Ab} \pm 0.05$
T2	$5.95^{Fb} \pm 0.03$	$5.70^{Eb} \pm 0.10$	$5.42^{Dab} \pm 0.08$	$5.20^{Cc} \pm 0.03$	$4.91^{Bbc} \pm 0.04$	$4.76^{Ab} \pm 0.07$
T3	$5.85^{Fa} \pm 0.07$	$5.60^{Ea} \pm 0.09$	$5.39^{Dab} \pm 0.06$	$5.08^{Ca} \pm 0.07$	$4.82^{Ba} \pm 0.03$	$4.63^{Aa} \pm 0.09$
T4	$5.81^{Fa} \pm 0.04$	$5.63^{Eab} \pm 0.06$	$5.38^{Da} \pm 0.04$	$5.11^{Cab} \pm 0.06$	$4.84^{Bab} \pm 0.09$	$4.58^{Aa} \pm 0.10$
			Titrable acidity (%)			
T1	$0.14^{Aa} \pm 0.03$	$0.25^{Bab} \pm 0.04$	$0.35^{Cab} \pm 0.06$	$0.46^{Da} \pm 0.04$	$0.59^{Ea} \pm 0.04$	$0.73^{Fa} \pm 0.03$
T2	$0.14^{Aa} \pm 0.04$	$0.23^{Ba} \pm 0.05$	$0.32^{Ca} \pm 0.06$	$0.41^{Da} \pm 0.04$	$0.62^{Ea} \pm 0.03$	$0.74^{Fa} \pm 0.06$
T3	$0.16^{Aa} \pm 0.05$	$0.28^{Bab} \pm 0.04$	$0.41^{Cbc} \pm 0.04$	$0.54^{Db} \pm 0.04$	$0.71^{Eb} \pm 0.06$	$0.80^{Fb} \pm 0.06$
T4	$0.15^{Aa} \pm 0.03$	$0.30^{Bb} \pm 0.06$	$0.44^{Cc} \pm 0.06$	$0.55^{Db} \pm 0.05$	$0.68^{Eb} \pm 0.06$	$0.82^{Fb} \pm 0.05$
			Free fatty acid (%)			
T1	$0.015^{Aa} \pm 0.005$	$0.046^{Bab} \pm 0.006$	$0.089^{Ca} \pm 0.009$	$0.107^{Da} \pm 0.009$	$0.152^{Ea} \pm 0.015$	$0.207^{Fab} \pm 0.009$
T2	$0.018^{Aab} \pm 0.007$	$0.043^{Ba} \pm 0.009$	$0.079^{Ca} \pm 0.008$	$0.108^{Da} \pm 0.013$	$0.149^{Ea} \pm 0.012$	$0.202^{Fa} \pm 0.016$
T3	$0.023^{Aab} \pm 0.007$	$0.055^{Bbc} \pm 0.009$	$0.093^{Cb} \pm 0.005$	$0.129^{Db} \pm 0.011$	$0.165^{Eab} \pm 0.012$	$0.217^{Fb} \pm 0.010$
T4	$0.026^{Ab} \pm 0.006$	$0.058^{Bc} \pm 0.008$	$0.097^{Cb} \pm 0.010$	$0.127^{Db} \pm 0.013$	$0.172^{Eb} \pm 0.012$	$0.221^{Fb} \pm 0.011$
			TBA (mg malonaldehyde/kg)			
T1	$0.10^{Aa} \pm 0.02$	$0.23^{Ba} \pm 0.06$	$0.42^{Ca} \pm 0.07$	$0.56^{Da} \pm 0.08$	$0.67^{Ea} \pm 0.04$	$0.81^{Fa} \pm 0.05$
T2	$0.12^{Aa} \pm 0.03$	$0.33^{Bb} \pm 0.07$	$0.55^{Cb} \pm 0.02$	$0.64^{Db} \pm 0.03$	$0.71^{Ea} \pm 0.05$	$0.88^{Fb} \pm 0.04$
T3	$0.18^{Aa} \pm 0.05$	$0.37^{Bbc} \pm 0.03$	$0.58^{Cbc} \pm 0.04$	$0.65^{Dbc} \pm 0.08$	$0.72^{Ea} \pm 0.06$	$0.91^{Fbc} \pm 0.03$
T4	$0.15^{Aa} \pm 0.04$	$0.42^{Bc} \pm 0.06$	$0.62^{Cc} \pm 0.05$	$0.72^{Dc} \pm 0.03$	$0.80^{Eb} \pm 0.01$	$0.93^{Fc} \pm 0.02$

a,b - Means with different superscripts in a column differ significantly at $p \leq 0.05$. A, B. Means with different superscripts in a row differ significantly at $p \leq 0.05$. T1: Steam cooked, T2: Microwave cooked, T3: Steam cooked+ Dehydrated, T4: Microwave cooked+ Dehydrated

Gadekar *et al.* (2008). The increase in protein content of dehydrated meat pickles is in agreement with the findings of Lee *et al.* (2003), who observed increase in protein content due to dehydration of meat product. The fat content of T1, T2, T3 and T4 was 9.82, 10.92, 16.15 and 14.97 per cent, respectively, and there was significant ($p<0.05$) difference among the four variants (Table 4). Similar results have been observed by Lee *et al.* (2003), where they found that dehydration increased the fat content.

The ash content analyzed in all the four types of products revealed that T1 had a value of 3.03 per cent and it differed significantly (P=0.05) from the products prepared involving dehydration i.e. T3 and T4, where it was 4.08 and 4.18%, respectively (Table 4). The higher ash content might have been due to higher dry matter content in the meat products prepared involving dehydration. The results observed for ash content in the meat pickle are in agreement to the observations of Das *et al.* (2013).

Storage studies

pH: pH values of samples prepared without dehydration (T1, T2) compared to that of prepared with dehydration (T3, T4) differed significantly (P=0.05 (Table 5). Similar trend was observed on 20th and subsequent days of storage. The low pH in dehydrated meat pickle may be attributed to higher absorption of vinegar in these products in comparison to non-dehydrated pickle. It has been observed that pH increased in control pickle from 5.5 to 5.72 and in the pickles containing acetic acid, lactic acid and citric acid, it reduced from 5.49 to 5.25, 5.11 and 5.27, respectively (Chellaram *et al.*, 2014).

pH values as observed on 0 to 100 day, at 20 days interval declined significantly (p=0.05) over storage time (Table 5). Significant reduction in pH of chicken pickle from 4.9 to 4.3 and 4.2 in PET jar and laminated pouches, respectively has also been observed with storage progression by Khanna *et al.*, 2004. Presence of mustard oil and vinegar are thought to be responsible for maintaining lower and sustained pH in pickle (Reddy and Rao, 1996). The continuous decrease in pH with the storage in the present study may have been due to increased absorption of vinegar with the progression in storage period.

Titrable acidity: Titrable acidity of pickles was analysed, on 0th, 20th and 40th day. Titratable acidity of the four variants did not differ significantly. However, it was on higher side for dehydrated variants (Table 5). Titrable acidity of dehydrated variants (T3 and T4) on 60th, 80th and 100th day was significantly higher (p=0.05) than non-dehydrated variants. The findings are in line with the pH values. This may be due to more absorption of vinegar in dehydrated meat pickle in comparison to non-dehydrated products. Sahu *et al.* (2012) reported a significant difference in titrable acidity of Murrel (Channastriatus) fish pickle with the variation in acetic acid concentration.

The titrable acidity of all the variants increased significantly (p=0.05) with progression of storage. The increase in titrable acidity with the advance in storage days can be attributed to increased permeation of vinegar with the increase in storage. Kumar and Basu, 2001 also have reported increase in titrable acidity from 0.36 to 0.75 during 120 days period of storage.

Free fatty acid: Free fatty acids (FFA) in T1 and T2 were lower in comparison to T3 and T4, which were significantly lower on 40th and 60th day. Similarly, on 100th day, FFA content of T2 differed significantly (p=0.05) from T3 and T4. The dehydration effect might have occurred due to higher proportion of fat in dehydrated meat products in comparison to non-dehydrated one. Moreover, the exposure of higher temperature during dehydration could have lead to higher free fatty acid production in comparison to non-dehydrated products. Usharani *et al.* (1992) studied quality of Indian commercial pickles and found that free fatty acid values of pickles with higher fat content were higher.

FFA values of all variants increased significantly from 0 to 100 days of storage (Table 5). This may have been due to lipid hydrolysis. Increase in free fatty acid with advancement of storage has also been previously observed in chicken pickle (Siddhu *et al.*, 1995).

TBA (Thio-barbituricacid) values: On day 0 the four variants did not differed significantly for TBA values (Table 5). It was observed that microwave cooking (T2) lead to higher TBA values in comparison to steam cooking (T1) on further storage. However this difference was not observed for dehydrated variants. Broncano *et al.* (2009) suggested that oxidation processes during cooking were more affected by a longer time and lower temperature than by a shorter time and higher temperature. They also reported that samples cooked by microwave had high levels of oxidation compounds even though the low temperature and short time used in the process, which suggests some interaction between microwave and meat fat which causes oxidation of polyunsaturated fatty acids.

TBA values increased with storage from 0 to 100 days. Similar trends have been observed for pickled chicken by Reddy and Rao (1996) and Nayak *et al.* (2011). The products stored for 100 days in this study had TBA values less than 1.0 mg malonaldehyde/kg, which indicates that all the products were well acceptable till 100 days of storage. According to Al-Khatani *et al.* (1996), meat products having TBA value of less than 3 mg

malonaldehyde/kg can be considered in good preservation state with reference to oxidative changes.

CONCLUSIONS

The highest product yield, protein and fat content were observed in T3 (steamcooked+dehydration). It is concluded that Kadaknath meat pickle prepared after dehydrating the meat pieces have more desirable features than those prepared with non-dehydrated meat.

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