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Research Paper

Studies on the Storage Stability of Chicken Meat Pickle with Lime Juice

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ABSTRACT

Lime juice is proposed as preservative for increasing the shelf life of chicken meat pickle. This study evaluated the antioxidant and antimicrobial activity of lime juice incorporated in chicken meat pickle at two different levels of 5% (T1) and 10% (T2). The chicken meat pickle was packed aerobically in 250 g polyethylene terepthalate (PET) jars and then stored at room temperature for 80 days under retail display conditions for evaluation of different physico-chemical, microbiological and sensory characteristics at regular interval of 20 days. Use of lime juice substantially brought down the pH and acidity of pickle, whereas it did not significantly ($p>0.05$) influenced the peroxide value, % FFA and 2- TBARS values of chicken meat pickle during 80 days of storage. Microbiological counts did not show substantial change and remained satisfactory throughout the 80 days of storage period. Neither storage period nor two levels of lime juice significantly ($p>0.05$) influenced the standard plate count of chicken meat pickle stored at room temperature. Yeast & moulds and coliforms were not observed up to 20 and 40 days of storage period respectively in the both the treatments. The sensory evaluation showed that chicken meat pickle added with 5 % lime juice (T1) was preferred compared to the 10% lime juice (T2).

Keywords : *Chicken meat pickle, Storage stability, Shelf stable, Lime juice*

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INTRODUCTION

Meat is a good source of high quality protein in the human diet. Preservation of highly perishable meat and meat products is serious problem in developing countries including India due to the temperate climate conditions (Bachhil 1982). Presently it has been reported that greater emphasis is being given on developing shelf stable meat products which can be stored at room temperature (Anjaneyulu 2005). Poultry industry has taken a quantum leap in the last three decades evolving from a near backward practice to a venture of industrial promotion. Along with this development availability of spent hens has also increased manifold but consumption of these spent hen meat is markedly less because of its toughness and poor sensory quality. Spent hen meat can be profitably utilized by converting it into value added meat products by application of suitable and acceptable processing technology to suit the taste of Indian consumers. "Meat Pickling" is one of such technological method suitable for preservation of meat at room temperature. Reduced water activity (a_w) and pH are the major hurdles contributing to shelf stability of pickles (Singh *et al.* 2015). Besides its preservative effect, pickling is also considered a means of imparting desirable characteristics such as flavor and taste to the food. Pickle is a low acidified food which has a maximum pH of 4.6 or less and a water activity greater than 0.85 (Food processor Institute 1998). Meat pickle is a traditionally ready to eat product and readily acceptable convenient meat product with good shelf stability at ambient temperature (Das *et al*. 2007) of indigenous origin. A good quality meat pickle can be developed from spent breeder hens which can be kept for longer time at room temperature without refrigeration facilities (Gadekar *et al.* 2008).

In the process of pickling, various synthetic acids are used to regulate the pH throughout the storage at room temperature, but now-a-days their usage was restricted owing to toxic effect. Consumer preferences for "natural" products have resulted an increased interest in the use of natural acids especially plant acid juices like amla juice (*Emblica officinalis*), lime juice (*Citrus limonium*) and mango (*Mangifera indica*) (Reddy *et al*. 2013) as preservative. Therefore, the objective of this study was to establish formulation of meat pickle and investigate the efficacy of lime juice at two levels (5 and 10%) on the physico-chemical, microbiological qualities as well as the acceptance of spent breeder hen chicken pickle kept at room temperature.

MATERIALS AND METHODS

The study was conducted in the Department of Livestock Products Technology, College of Veterinary Science, Tirupati from the month of June 2015 to August 2015 and the room temperature around (32±2°C).

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Source of meat: Around 80 weeks old spent breeder hens were purchased from the local market and they were slaughtered hygienically in the department and deboned chicken chunks (2-4cm) were used for the pickle preparation.

Methodology: Formulations for preparation of chicken pickle using lime juice at the rate of 5 % (T1) and 10% level (T2), are presented in the Table 1. For preparation of chicken pickle, the deboned chicken pieces were added with 150 ml of potable water and pressure cooked for 15 min. The cook-out broth was discarded by straining and cooked chicken pieces were deep fat fried in the oil till slight golden brown color appeared. For preparation of dry spice mix, all ingredients (red chili, coriander, mustard and cumin) used in preparation were first roasted gently in a pan and then ground into fine powder. For green curry stuff preparation, all ingredients (onion, ginger and garlic) were peeled and then crushed in the grinder to convert them into paste. The dry and green spice mix was fried in the remaining oil that is left out in the pan after frying of chicken pieces for 15 min and then added the fried chicken pieces and then allowed to cook for 10 min with spice mix. A top up quantity (10ml) of heated and cooled mustard oil and lime juice were added to the pickle and it was kept for maturation for 24 h at room temperature. After that, pickle was packed in the polyethylene terepthalate (PET) 250 g jars and stored at room temperature (32±2°C).

Table 1: Cycling conditions used for two sets of primers

S.No	Name of the ingredients	Quantity	
		T1	T2
1.	Cooked chicken meat pieces (g)	100	100
2.	Common salt (%)	8	8
3.	Green curry stuff (%)	17	17
4.	Dry spice mix (%)	24	24
5.	Lime juice (%)	5	10
6.	Refined oil (ml)	70	70

T1- 5% lime juice added chicken meat pickle; T2-10% lime juice added chicken meat pickle. **n=2**

Analysis of samples: After maturation of one day period, changes in physico- chemical, microbiological and organoleptic properties were monitored at an interval of 20 days up to 80 days. The pH was determined by using the method of Strange *et al*. (1977). TBARS value was estimated as per the procedure given by Tarladgis *et al.* (1960). Free fatty acids (FFA) and peroxide value (PV) were evaluated as per procedure of modified AOAC (1995) and acid value as per Flemming *et al*. (1984). Standard plate counts (SPC), Coliform count (CFC) and Yeast and mould count (YMC) were determined by following the methods as described by ICMSF (1978). The product was subjected to a 6 member taste panel including staffs and students for sensory evaluation by using a 9 point descriptive scale. The data thus obtained was subjected to statistical analysis using SPSS MAC, version 20.0, SPSS Chicago (US).

RESULTS AND DISCUSSION

Physico-chemical characteristics

pH: The changes in the physico-chemical characteristics of chicken meat pickle during storage at room temperature are shown in Table 2. There was a slight decrease ($p>0.05$) in pH from 0 to 20 days of storage then it was increased throughout the storage period though it was not significant ($p>0.05$) up to 40 days but there was significant ($p<0.05$) difference observed from subsequent days of storage i.e, from 40 to 80 days in both the treatments. The pH of pickle ranged between 4.25±0.01 to 4.74±0.01, but all values are well below the pH value of 5.00 which is considered to be critical for storage stability of meat pickles (Dziezak 1986). Among two treatments 10 % lime juice added chicken meat pickle had significantly ($p<0.05$) lower pH than 5 % lime juice added chicken meat pickle. The slight increase in pH after 40 days of storage might be due to the accumulation of metabolites by bacterial action (Jay, 1996) in meat in addition to protein and amino acid degradation resulting in formation of ammonia and consequent increase in pH. These results are in agreement with Das *et al*. (2007) in goat meat pickle and Das *et al.* (2013) in meat pickle prepared from spent chicken stored at room temperature. Furthermore, pH of the boiled, boiled + fried rabbit meat pickle and boiled, boiled +fried rabbit liver pickle was increased from 0 day to 60 days of ambient storage (Sen and Karim 2003). Significant reduction in pH of chicken pickle from 4.9 to 4.3 and 4.2 in PET jar and laminated pouches was observed (Khanna *et al.* 2004). After maturation period of 3 days, the pH of cooked chicken meat pickle was stabilized between 4.64 and 4.67 (Gadekar *et al.* 2008).

2-TBARS values: A significant ($p<0.05$) increase in the overall mean TBARS values of two treatments during 80 days of storage were noticed (Table 2). Initially up to 40 days these increase in TBARS values are not statistically significant ($p>0.05$) but from 40 to 80 days significant ($p<0.05$) increase in TBARS values was noticed. As the storage period increasing the TBARS values also increasing in both 5 % and 10 % lime juice added chicken meat pickle samples. This might be due to auto-oxidation of lipids over a period of room temperature storage and pro-oxidant nature of added salt. In the present study, the overall mean TBARS values of chicken meat pickle of two treatments (T1 and T2) were not having any significant difference during entire storage period of 80 days. The results

Table 2: Effect of incorporation of lime juice on the physico-chemical properties of chicken meat pickle during storage at room temperature (Mean ± S.E)

Treatments	Storage days					Overall
	0	20	40	60	80	treatment mean
			pH			
T1	4.52±0.02	4.26±0.01	4.32±0.05	4.74±0.03	4.92±0.01	4.52±0.01^{A}
T2	3.98±0.01	3.87±0.04	4.02±0.09	4.21±0.02	4.56±0.05	4.12±0.01^{B}
Overall days mean	4.25±0.01^{a}	4.06±0.03^{a}	4.17±0.04^{a}	4.47±0.08^{b}	4.74±0.01^{c}	
			2-TBARS value (mg malonaldehyde/kg of meat)			
T1	0.29±0.05	0.28±0.09	0.34±0.05	0.41±0.02	0.56±0.09	0.37±0.01^{A}
T2	0.29±0.09	0.30±0.01	0.31±0.02	0.35±0.05	0.41±0.06	0.33±0.08^{A}
Overall days mean	0.29±0.07^{a}	0.29±0.05^{a}	0.32±0.05^{a}	0.38±0.04^{b}	0.48±0.07^{c}	
			Peroxide value			
T1	41±0.01	36±0.02	52±0.05	49±0.01	54±0.01	46.4±0.05^{A}
T2	35±0.01	38±0.01	42±0.05	45±0.03	46±0.01	41.2±0.02^{A}
Overall days mean	38±0.03^{a}	37.5±0.02^{a}	47±0.05^{b}	47±0.09^{b}	50±0.09^{c}	
			Per cent free fatty acid content			
T1	0.54±0.02	0.66±0.08	0.59±0.05	0.74±0.05	0.85±0.03	0.67±0.02^{A}
T2	0.56±0.01	0.59±0.08	0.64±0.04	0.71±0.01	0.71±0.02	0.64±0.09^{A}
Overall days mean	0.55±0.06^{a}	0.62±0.06^{a}	0.61±0.025^{a}	0.72±0.09^{b}	0.78±0.03^{b}	
			Acidity			
	1.61±0.01	1.52±0.09	1.68±0.09	1.52±0.08	1.72±0.01	1.61±0.01^{A}
	1.81±0.02	1.75±0.09	1.69±0.03	1.78±0.07	1.85±0.01	1.77±0.07^{B}
Overall days mean	1.71±0.09^{a}	1.63±0.04^{a}	1.68±0.04^{a}	1.65±0.03^{a}	1.78±0.04^{a}	

T1- 5% lime juice added chicken meat pickle; T2-10% lime juice added chicken meat pickle.
Means with different superscripts in a row and column wise differ significantly ($p < 0.05$)

were in accordance with Das *et al*. (2013) in spent chicken meat pickle and Singh *et al.* (2015) in quail meat pickle stored at room temperature. In addition to these, progressive increase in TBA value in chicken parts was reported by Reddy and Rao (1996). There was significant ($p<0.01$) increase in TBA values of pickle from 0.373 mg/kg of malonaldehyde to 1.036/ kg of malonaldehyde on 90th day of ambient storage (Shukla and Srivastava 1999). 2- TBARS values increased significantly from (1.79 ppm) control and (1.33 ppm) antioxidant treated buffalo meat pickle to 2.13 ppm and 1.42 ppm on 90th day of storage (Khate 2002). Incorporation of sodium ascorbate had significantly ($p<0.01$) reduced the rate of lipid oxidation in cooked chicken meat pickle (Gadekar *et al*. 2008).

Peroxide value: The peroxide value of chicken meat pickle was increased steadily from 0 to 80 days of storage. After 40 days of storage, a significant ($p<0.05$) increment in peroxide value noticed. Addition of 5 and 10 % lime juice did not significantly ($p>0.05$) influenced in peroxide value of chicken meat pickle during room temperature storage. The range of peroxide values in T1 is 41±0.04 to 54±0.08 and T2 is 35±0.05 to 46±0.01. A gradual increase in peroxide value in both T1 and T2 samples observed. Non enzymatic lipid oxidation during room temperature storage could be the possible reason for gradual and non-significant increase in peroxide value of chicken meat pickle. Similar observations were noted by Puttarajappa *et al*. (1996) in chicken pickle and Kanagaraju and Subramanian (2012) in spent duck meat pickle stored for different periods (up to 90th day) at room temperature.

Per cent free fatty acid value: As the storage period progressing, gradual increases in per cent free fatty acid (% FFA) content were noticed throughout the storage period. The significant increase in % FFA content values were noticed from 60 days onwards. The range of % FFA contents in T1 is 0.54±0.02 to 0.85±0.03 and T2 is 0.56±0.01 to 0.71±0.02. 10 % lime juice added sample (T2) had lower % FFA content values than 5 % lime juice added sample (T1), but these differences were not significant throughout the storage. The gradual increase in % FFA contents in both samples might be due to lipid hydrolysis and bacterial multiplication which is evidence by increased standard plate count during storage. These results are in agreement with Puttarajappa *et al.* (1996) in chicken pickle, Kanagaraju and Subramanian (2012) in spent duck meat pickle stored for different periods (up to 90th day) at room temperature and Chellaram (2015) in *Pleuroploca trapezium* meat pickle.

Acidity: The acidity value of chicken meat pickle incorporated with 5 and 10 % lime juice did not vary significantly ($p>0.05$) by storage intervals during room temperature. But the

concentration of lime juice is significantly influenced the acidity values of chicken meat pickle ($p<0.05$). The range of acidity values in T1 is 1.52±0.09 to 1.72±0.01 and T2 is 1.69±0.03 to 1.85±0.01. The variations of acidity values during storage might be due to more loss of moisture, which in turn could have increased concentration of undissociated molecules of citric acid in lime juice. The significant increase in acidity values in 10 % lime juice compared to 5% added lime juice samples might be due to initial higher concentration of lime juice which contains natural citric acid. These results are in accordance with Kanagaraju and Subramanian (2012) in spent duck meat pickle stored for different periods (up to 90th day) at room temperature and Wani and Majeed (2014) in chicken gizzard pickle. But contrary to this results, Das *et al*. (2007) observed a significant ($p<0.05$) difference of acidity values affected by storage intervals in low acid goat pickle stored at room temperature.

Microbial characteristics: The effect of incorporation of two levels of lime juice on microbial characteristics of chicken meat pickle stored at room temperature presented in Table 3. Neither storage period nor two levels of lime juice significantly ($p>0.05$) influenced the standard plate count of chicken meat pickle stored at room temperature. The range of standard plate count in T1 is 1.97±0.02 log cfu/g to 2.55±0.03 log cfu/g and in T2 is 1.86±0.01 log cfu/g to 2.14±0.02 log cfu/g. The microbiological levels are within limits in entire storage period. The yeast and mould count was not noticed in both lime juice treated samples up to 20 days and from 40 days onward a gradual increase in yeast and mould count were noticed. Addition of 5 and 10 % added lime juice significantly ($p<0.05$) influenced the yeast and mould count of chicken meat pickle. The coliform counts were not detected up to 40 days of storage in chicken meat pickle stored at room temperature. From 60 to 80 days only the growth of coliforms was detected. Storage intervals did not significantly ($p>0.05$) influenced the growth of coliforms but addition of lime juice significantly ($p<0.05$) influenced the growth of coliform counts. The inhibitory effect on microbial growth during storage might be due to citric acid which is present in added lime juice. The mode of action of this organic acid might be direct pH reduction of substrate, depression of internal cellular pH or disruption of substrate transport by alteration of cell membrane permeability. In addition to inhibitory substrate transport, organic acids may inhibit NADH oxidation, thus eliminating supplies of reducing agents to electron transport system. Furthermore, due to the heat treatment, organic acid and low pH also major factors for increasing the safety against microorganisms of pickled products (Young-Lee 2004). Multiplication of yeast and mould in chicken meat pickle samples may be due to their ability of to grow in acidic environment. Yeast and mould can also grow over a wide range of salt concentrations and moisture contents of foods. These results are corroborate with findings of Singh *et al.* (2015) in quail meat pickle added with amla, mango and lime juices stored at room temperature, Das *et al*. (2007) in low acid goat meat pickle and Das *et al*. (2013) in spent chicken meat pickle.

Organoleptic properties: The results of influence of lime juice on organoleptic properties of chicken meat pickle were presented in Table 4. The appearance scores of chicken meat pickle was did not significantly ($p>0.05$) influenced by the concentration of lime juice, but storage intervals are significantly ($p<0.05$) influenced from the 60th day onwards. Up to 40 day a non-significant increase in appearance scores were observed during room temperature storage. The range of appearance scores in treatments are between 6.14 ±0.01 to 8.09±0.01. 5% lime juice added chicken meat pickle had higher appearance scores compared to 10% lime juice added chicken meat pickle. As the progressing of storage period a gradual decrease in appearance scores were noted. Similar observations were noted in both flavor and mouth coating scores of chicken meat pickle. The ranges of flavor scores are between 7.12±0.01 to 8.22±0.02 and mouth coating scores are ranged between 7.14±0.03 to 8.49±0.03. Neither storage intervals nor concentration of lime juice significantly ($p>0.05$) influenced the both flavor and appearance scores of chicken meat pickle. Sourness is very important parameter in regard to organoleptic evaluation of meat pickles. The concentration of lime juice is significantly ($p<0.05$) influenced the sourness scores of chicken meat pickle, but storage intervals did not significantly ($p>0.05$) influenced the sourness scores up to 60 days of storage at room temperature. The sourness scores between 60 and 80 days significantly ($p<0.05$) influenced by storage interval. The chicken meat pickle incorporated with 5 % lime juice had significantly ($p<0.05$) higher sourness scores (low sourness intensity) than 10 % lime juice added sample. The sensory panelists felt intense sourness in 10 % lime juice added sample. The overall acceptability scores are the cumulative values of appearance, flavor, mouth coating and sourness scores. These scores significantly ($p<0.05$) influenced by concentration of lime juice. As the progressing of storage period, the overall acceptability scores non-significantly ($p>0.05$) decreased and ranged between good to very good. 5 % lime juice added chicken meat pickle had significantly ($p<0.05$) more overall acceptability scores compare to 10 % lime juice added chicken meat pickle samples. These results are in accordance with Kanagaraju and

Table 3: Effect of incorporation of lime juice on the microbiological properties of chicken meat pickle during storage at room temperature (Mean ± S.E)

Treatments	Storage days					Overall
	0	20	40	60	80	treatment mean
Overall Standard plate count (log10cfu/g of meat)						
T1	1.97±0.02	2.09±0.02	2.18±0.03	2.27±0.01	2.55±0.01	2.21±0.02 ^{A}
T2	1.86±0.01	1.92±0.03	2.04±0.01	2.08±0.03	2.14±0.02	2.00±0.04 ^{A}
Overall days mean	1.91±0.01 ^{a}	2.00±0.01 ^{a}	2.11±0.06 ^{a}	2.17±0.01 ^{a}	2.34±0.06 ^{a}	
Yeast and mold count (log_{10}cfu/g of meat)						
T1	NIL	NIL	1.42±0.04	1.56±0.01	1.65±0.02	1.54±0.07 ^{A}
T2	NIL	NIL	1.27±0.04	1.43±0.02	1.57±0.02	1.42±0.02 ^{B}
Overall days mean			1.34±0.03 ^{a}	1.49±0.07 ^{a}	1.61±0.04 ^{b}	
Coliform count (log_{10}cfu/g of meat)						
T1	NIL	NIL	NIL	0.21±0.09	0.32±0.03	0.26±0.01 ^{A}
T2	NIL	NIL	NIL	0.11±0.02	0.21±0.01	0.16±0.02 ^{B}
Overall days mean				0.16±0.01 ^{a}	0.26±0.02 ^{a}	

T1- 5% lime juice added chicken meat pickle; T2-10% lime juice added chicken meat pickle.
Means with different superscripts in a row and column wise differ significantly ($p < 0.05$)

Subramanian (2012) in spent duck meat pickle acceptable even at the end of 90 days at room temperature, Das *et al.* (2013) in spent chicken meat pickle and Singh *et al.* (2015) in quail meat pickle incorporated with amla juice, lime juice and mango juice stored at room temperature. In addition to this study, sensory attributes of the product such as general appearance, texture, sourness, saltiness did not alter (score ranged between 6.33-5.80) and the product remained acceptable throughout the storage period of 3 months. The flavour score of the pickle decreased significantly ($p<0.01$) but the product remained fairly acceptable up to 90 days (Shukla and Srivastava 1999).The sensory evaluation of the pickle showed that the chicken pickle was acceptable even at the end of 6 months (Puttarajappa *et al*. 1996). There was significant decline in flavour score of rabbit pickle during storage (Sen and Karim 2003). Incorporation of sodium ascorbate had significantly

Table 4: Effect of incorporation of lime juice on the microbiological properties of chicken meat pickle during storage at room temperature (Mean ± S.E)

Treatments	Storage days					Overall
	0	20	40	60	80	treatment mean
Appearance						
T1	7.97±0.05	8.09±0.01	7.27±0.02	7.18±0.01	6.55±0.01	7.41±0.08 ^{A}
T2	7.86±0.06	7.92±0.02	7.64±0.01	7.08±0.03	6.14±0.01	7.33±0.01 ^{A}
Overall days mean	7.91±0.08 ^{a}	8.00±0.06 ^{a}	7.45±0.01 ^{a}	7.13±0.02 ^{b}	6.34±0.09 ^{b}	
Flavor						
T1	7.65±0.05	8.22±0.02	8.18±0.02	7.32±0.01	7.15±0.01	7.70±0.01 ^{A}
T2	7.56±0.06	7.85±0.01	7.72±0.01	7.66±0.03	7.12±0.01	7.58±0.02 ^{A}
Overall days mean	7.60±0.03 ^{a}	8.03±0.02 ^{a}	7.95±0.09 ^{a}	7.49±0.02 ^{a}	7.13±0.08 ^{b}	
Mouth coating						
T1	7.27±0.05	8.49±0.03	7.88±0.01	7.91±0.01	7.55±0.01	7.82±0.05 ^{A}
T2	7.66±0.06	7.92±0.02	7.94±0.03	7.38±0.03	7.14±0.03	7.60±0.06 ^{A}
Overall days mean	7.46±0.08 ^{a}	7.84±0.05 ^{a}	7.91±0.01 ^{a}	7.64±0.02 ^{a}	7.57±0.04 ^{a}	
Sourness						
T1	7.67±0.05	7.89±0.02	7.58±0.01	7.37±0.01	7.15±0.01	7.53±0.09 ^{A}
T2	7.16±0.06	7.12±0.01	7.04±0.01	6.58±0.03	6.06±0.02	6.79±0.04 ^{B}
Overall days mean	7.41±0.08 ^{a}	7.50±0.02 ^{a}	7.31±0.05 ^{a}	6.97±0.02 ^{a}	6.60±0.09 ^{b}	
Overall acceptability						
T1	7.25±0.09	7.95±0.05	7.51±0.03	6.52±0.01	6.12±0.08	7.07±0.03 ^{A}
T2	6.59±0.01	7.01±0.02	6.95±0.03	6.21±0.05	6.01±0.01	6.55±0.05 ^{B}
Overall days mean	6.92±0.05 ^{a}	7.48±0.05 ^{a}	7.23±0.04 ^{a}	6.36±0.09 ^{a}	6.06±0.04 ^{b}	

T1- 5% lime juice added chicken meat pickle; T2-10% lime juice added chicken meat pickle.
Means with different superscripts in a row and column wise differ significantly ($p < 0.05$).

improved the sensory attributes of pickle especially appearance and flavour throughout the storage period (Gadekar *et al.* 2008).

From the above results, the chicken meat pickle is stable up to 80 days without any deteriorative changes at room temperature, so it is considered as shelf stable. Though both samples (T1 and T2) are microbiologically stable at room temperature up to 80 days, chicken meat pickle added with 5 % lime juice (T1) had recorded superior organoleptic scores compared to 10 % lime juice added (T2) samples. Thus, it is concluded that chicken meat pickle added with 5 % lime juice is beneficial for shelf stable chicken meat pickles up to 80 days during room temperature (32±2°C) without any deteriorative changes.

REFERENCES

Anjaneyulu ASR (2005) Hurdle technology for shelf stable meat products. In: Recent advances in poultry and egg processing quality assessment of poultry products - Short-term training course, CARI, Izatnagar, Bareilly (U. P.) pp: 63-68

AOAC (1995) Official Methods of Analysis. 6thEdn. Association of Official Analytical Chemists, Washington, DC., USA

Bachhil VN (1982) Observations on seasonal variations in microbial load. Proceedings of the 23rd Annual conference on fermented foods, food contaminants bio fertilizers and bio energy, Association Microbiologists of India, Mysore

Chellaram C (2015) Chemical composition, shelf life studies and popularization on *Pleuroploca trapezium* meat pickle. J Chem Pharm Res 7 (1):25-30

Das AK, Sharma RB, Singh NP (2007) Quality and storage stability of low acid goat meat pickle. Am J Food Technol 2 (6): 550-554

Das A, Nath DR, Hazarika M, Laskar SK (2013) Studies on certain quality attributes of meat pickle prepared from spent chicken. Vet World 6(3): 156-158

Dziezak JD (1986) Antioxidants and antimicrobial agents. Food Technol 40:94-111

Flemming HP, Mcfeeters RF, Etchells JL, Bill TA (1984) Pickle vegetables. In: Compendium of methods for the microbiological examination of foods. Speck M.L (Ed.). American Public Health Association, Washington DC, pp 663

Food Processor Institute (1998) Canned foods-principles of thermal process control, acidification and container closure evaluation, Washington DC: FPI

Gadekar YP, Anjaneyulu ASR, Kandeepan G, Mendiratta SK, Kondaiah N (2008) Safe pickle with improved sensory traits: Effect of sodium ascorbate on quality of shelf stable pickled cooked chicken. Fleischwirt Int 4: 56-62

ICMSF (1978) International Commission on Microbiological Specifications of Foods. Micro-Organism in Foods 1. Their significance and methods of enumerations. University of Toronto Press. Toronto

Jay JM (1996) Modern Food Microbiology 4th edition CBS publication and distributors, New Delhi

Kanagaraju P, Subramanian A (2012) Preparation of spent duck meat pickle and its storage studies at room temperature. Am J Food Technol DOI:10.3923/ajft.2012:1-5

Khanna N, Sharma DP, Ahlawat SS, Sahoo J (2004) Shelf stable bone in meat pickle from spent hen. J Food Sci Technol 41:445-447

Khate K (2002) Studies on development of buffalo meat pickle. MVSc Thesis, Deemed Univ. IVRI, Izatnagar, Bareilly (India)

Puttarajappa P, Nair KKS, Rao DN (1996) Studies on shelf stable chicken. J Food Sci Technol 33: 501-503

Reddy KP, Rao BE (1996) Storage quality characteristics of pickled chicken parts. Indian J Poult Sci 31: 153-155

Reddy GV, Sen AR, Nair PN, Reddy KS, Reddy KK, Kondaiah N (2013) Effects of grape seed extract on the oxidative and microbial stability of restructured mutton slices. Meat Sci 95(2): 288-294

Sen AR, Karim SA (2003) Storage stability of rabbit pickle at room temperature. J Food Sci Technol 40: 197-200

Shukla PK, Srivastava RK (1999) Effect of antioxidant on shelf life of chicken pickle. Indian J Poult Sci 34: 405-408

Singh HO, Singh HN, Singh VP, Kumar A (2015) Microbiological stability of aerobically packaged quail meat (bone-in) pickle at room temperature (30±2°C). J Livestock Sci 6: 16-22

Strange ED, Benedit RC, Smith JL, Swift CE (1977) Evaluation of rapid test for monitoring alterations in meat quality during storage. J Food Prot 40:843-847

Tarladgis BG, Watts BM, Yonathan M (1960) Distillation method for the determination of malonaldehyde in rancid foods. J Am Oil Chem Soc 37 (1):44-48

Wani SA, Majeed D (2014) Evaluation of quality attributes and storage stability of pickle prepared from chicken gizzard. J Meat Sci and Technol 4: 85-89

Young-Lee S (2004) Microbial safety of pickled fruits and vegetables and hurdle technology. Int J Food Safety 4:21-32