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Review Article
Shelf stable meat pickles- a review

*[1]Gadekar, Y. P., [1]Kokane, R. D., [1]Suradkar, U. S., [2]Thomas, R., [3]Das, A. K. and [4]Anjaneyulu, A. S. R.

[1]*Department of Livestock Products Technology*
Bombay Veterinary College, Parel, Mumbai, M.S. -400 012.
[2]*National Research Centre on Pig, Rani, Guwahati, Assam - 781131*
[3]*Central Institute for Research on Goats, Makhdoom, Farah, Mathura, U. P. - 281 122*
[4]*National Research Centre on Meat, Hyderabad, A. P. - 500 039*

Abstract: Meat is a nutrient dense food. But due to its perishable nature, meat and meat products require considerable input for chilling or freezing during storage and marketing. Meat provides a suitable environment for proliferation of meat spoilage microorganisms and common food-borne pathogens, therefore adequate preservation technologies must be applied in order to preserve its safety and quality. Preservation of meat either in fresh or in processed form requires considerable energy. High perishability of meat and meat products is serious problem in tropical countries. Now days there is need to develop the foods which are shelf-stable so that can be distributed in various locations without aid of refrigeration. Pickling is one of the alternatives to develop such kind of products.

Keywords: Entrepreneurship development, keeping quality, pickling, meat products

Introduction

Traditional foods enrich our sensory perception by providing wide variety of flavours, colours and textures. Pickling is an age-old traditional method for preservation of vegetables and fruits. Pickled products are common in Indian diets and are much relished by consumers. Meat pickles are traditional shelf stable ready to eat products. Presently more emphasis is given on developing shelf stable meat products, which can be stored at ambient temperature. Shelf stable meat products like, canned and cured meat products, meat and snack type meat products, meat pickles, intermediate moisture meat products have been reported (Anjaneyulu, 2005).

Pickling of perishable foods in vinegar or edible oil with added salt, spices and condiments provide ready to eat product with good shelf stability at ambient temperature. Reduced water activity (aw) and pH are the two major hurdles contributing to shelf stability of pickles. Along with preservative effect pickling also helps to improve desirable characteristics like colour, flavor and texture. With change in life style, increased per capita income, urbanization, consumer awareness and increasing number of women entering in job has created rising demand for ready to eat, heat and serve convenience meat products.

Chicken pickles

Vinegar and oil based spent chicken pickle was having good consumer acceptance (Chatterjee *et al.,* 1969) Indigenous style poultry meat pickle was prepared using deboned broiler meat, spices, vinegar, salt and 0.2% sodium benzoate. The method involved cooking of meat followed by light frying, equilibrating the pH, addition of a spice mix and 0.2% sodium benzoate. After filling in bottles the product was covered with heated and cooled oil. Organoleptically and microbiologically product was found satisfactory over 10 months of storage (Haleem *et al.,* 1996).

Chicken pickle was prepared by using meaty portions of spent hens like breast, thigh and drumstick. After pressure cooking for 15 min, cooked chicken parts were pickled in pre-sterilized glass bottles. Pickled chicken parts were quite acceptable to the

*Corresponding author.
Email: *yogirajlpt@gmail.com*

panelists even after 80 days of ambient storage (Reddy and Rao, 1996). Quality changes of chicken pickle during ambient storage (26 to 28°C) were reported by Puttarajappa *et al.* (1996). Storage stability of chicken pickle was evaluated using two types of pouches made from metalized polyester/polyethylene and co-extruded film of polyethylene/ polyamide/ethylene-acrylic acid films. The product was evaluated for 90 ad 180 days storage at accelerated condition (38°C with 90% RH) and normal condition (27°C with 65% RH). There was progressive increase in free fatty acid and peroxide value. With advancement of storage, decrease in sensory quality occurred but the product was microbiologically safe for consumption up to 6 months. (Siddhu *et al.,* 1995).

Quality changes in chicken pickle prepared using antioxidant butylated hydroxytouelene (BHT) at 200 ppm were studied at 30 days interval. The product was acceptable up to 90 days (Shukla and Srivastava, 1999b). Chicken pickle made from bone in meat from spent white leghorn hen was packed in polyethylene-terephthalate (PET) jars and polyethylene (PE) pouches. No significant difference in pH, titratable acidity and TBA values of products kept either in PET or laminated pouches were observed and product was acceptable upto 6 months (Khanna *et al.,* 2004). The shelf life of pre-cooked chicken meat pickle with and without antioxidant (sodium ascorbate) was evaluated at ambient temperature (15 to 30°C) during months of January to April at 30 days interval up to 90 days for physicochemical, microbiological and sensory qualities. Even after storage of 90 days at ambient temperature, cooked meat pickle, especially the sodium ascorbate treated pickle was well acceptable and was rated between good and very good (Gadekar *et al.,* 2008).

Quail pickles

Quail meat pickle was prepared using four different pickling solutions. The pickles were stored in glass jar at room temp (26°C) and refrigeration (5±1°C) storage. The both the pickles were organoleptically safe upto 60 days (Singh *et al.,* 1982). Whole quail carcasses after frying in refined mustard oil were pickled using 25% vinegar, table salt, spices and condiments. Pickle was stored in pre-sterilized glass jars at room (29°C) and refrigerated (5±1°C) temperatures for 6 months. The product was organoleptically acceptable up to 5 months at both temperatures (Singh and Panda, 1984).

Guinea fowl pickles

Vinegar based guinea fowl meat pickle was safe at ambient temperature (29-30°C) for period of 3 months without any appreciable loss in microbial and sensory quality (Rana and Shukla, 2003).

Gizzard pickles

Chicken gizzards were fried and stored under ambient temperature (15-21°C, 69-82% RH) and at refrigerated temperature (4±1°C, 80% RH). Physico-chemical, microbiological, and organoleptic properties were found to be satisfactory up to a storage period of 7 days at ambient and 14 days at refrigerated temperature respectively. (Pangas *et al.,* 1998). Chicken gizzard pickle containing 4% ground mustard *(Brassica juncea)* seed was compared with pickle prepared using modified traditional recipe containing 2% mango powder (amchoor) Use of ground mustard seed improved acceptability. Though, the values were comparable to those for traditional recipes varying from good to very good for all sensory attributes (Kesava Rao *et al.,* 1994). Gizzard pickle was found to be safe for consumption up to 45 and 75 days of storage in summer-rainy and winter seasons respectively and its quality was comparable with refrigerated pickle (Sachdev *et al.,* 1994).

Chicken gizzard pickles and *chutneys* were prepared with green curry stuffs (5%) and without green curry stuffs (paste of onion, ginger and garlic) using 10% vinegar and 0.5% citric acid. Pickles and chutneys with green curry stuff were preferred than those recipes with spice mix alone (Sharma *et al.,* 1986). Oil and vinegar based spicy, sweet and sour pickles were standardized using control (distilled water) and treated (papain 0.1% and Sodium tripolyphosphate 0.5%) (Grover *et al.,* 2004).

Mutton/chevon pickles

Using chevon and mutton in 10% vinegar indigenous recipe was developed for preparation of pickles. The shelf life of the product was attributed to high salt content, low pH, low moisture, cooking and frying (Padda and Sharma, 1982). Chevon pickle was prepared using 1% acetic acid and 4% salt was acceptable up to 60 days at room temperature (Pal and Agnihotri 1994). Highly acceptable low acid goat meat pickle was evaluated for its storage stability at 32±0.5ºC. The pickle was acceptable upto 60 days at ambient storage. (Das *et al.,* 2007).

Pork pickles

Bone-in and boneless pork pickles were prepared with 25% and 50% back fat cubes and 10% vinegar. Panelists rated both recipes between good to very good (Padda *et al.,* 1985). Pork pickle was prepared using BHT at different levels. During storage, shelf-life of pickle was evaluated by using different packaging

materials like high density polyethylene (HDPE) and laminate (PET/PE). Addition of BHT in pickle maintained better flavour and overall acceptability, and laminate (PET / PE) was found to be better than HDPE for containing the pork pickle (Pal, 1990).

Buffalo meat pickle

Buffalo meat pickle using 4% salt and 1% acetic acid and specialty buffalo meat pickle of Nagaland using 2.4 % salt and 0.2 acetic acid was prepared. Organoleptic evaluation indicated that the appearance of both the products was decreased gradually with increasing storage. (Khate, 2002).

Rabbit pickle

Rabbit pickle was prepared using 1% acetic acid and 4% salt from deboned meat and liver of male rabbits. Significant reduction ($P<0.005$) in organoleptic score of pickle with advancement of storage period was reported (Sen and Karim, 2003).

Shelf stable meat Products

Meat preserve was prepared using brine containing 25% salt in 5% acetic acid. The desired moisture level of 38-40% was achieved by frying pork slices in oil between 150-160^{o}C for about 30 min. Product was found to be organoleptically and microbiologically safe up to 6 months at ambient storage (Puttarajappa *et al.,* 1990). Shelf stable chicken curry was developed using concept of hurdle technology. The product was stable up to 2 months at ambient temperature and upto 4 months at 4^{o}C when packed in PFP (Paper/ Aluminium/ PE) laminate. (Deepa *et al.,* 2003). Ready-to-eat mutton curry was prepared by using hurdle technology (Das and Radhakrishna 2001), which after a few minutes of heating in boiling water could be served in the curry form. Various hurdles like a_w, pH, preservatives, high temperature, low temperature and redox potential were employed. The resultant product with about 38% moisture and 5.6 pH was stable for more than 4 months at ambient temperature of 27^{o}C. Traditional goat meat *keema* using Hurdle Technology for extending the shelf life was standardized (Karthikeyan *et al.,* 2000). The hurdle treated *keema* had shelf life of 3 days at 35±1^{o}C and 18 days at refrigerated storage (4±1^{o}C). The hurdle treated *keema* had comparable sensory attributes with that of control.

Storage studies on shelf stable products

1. Physicochemical quality changes

a. pH and titratable acidity

Increasing the acidity of foods, either through fermentation or the addition of weak acids, has been used as a preservation method since ancient times. Organic acids are more effective preservatives in undissociated state. Lowering the pH of a food increases the effectiveness of an organic acid as a preservative. The pH of the food also significantly impacts the lethality of heat treatment of the food. pH value below 5.0 is considered critical for storage stability of meat products (Dziezak, 1986). Higher acidity, salt content, cooking, frying and low moisture reduces the microbial load of the product. At zero hour the pH of chevon and mutton pickles prepared from bone-in and boneless were about 3.90, 3.80 and 3.60, respectively which increased to 4.90, 4.20 and 4.80, 4.70 on maturation after 6 days (Padda and Sharma, 1982).

There was rapid increase in pH of pickle solution containing 50% and 75% vinegar from 3.05 and 2.70 at zero hr to 4.25 and 4.0 respectively after 6 hr immersion of quail carcasses. The equilibrium pH was observed on 4th day (Singh *et al.,* 1982). In pork pickle an average pH of 3.90 to 5.07 was observed by Padda *et al.* (1985) during 3 days maturation period. Stable pH in pork pickle was observed after a maturation period of 9 days. Chicken gizzard pickle took 72 hours to reach equilibrium in pH (Sharma *et al.,* 1986).

After a maturation period of 7-8 days, pH of pork pickle was found to be stable and thereafter the increase in pH up to 150 days of storage was reported to be negligible. The overall mean titratable acidity of control and standardized pickle were reported to be 0.61 to 1.06 respectively. The titratable acidity was not affected by packaging materials and storage period (Pal, 1990). There was slight increase in pH of chevon pickle from 4.71 to 4.77on 60th day of storage. Up to 45 days the titratable acidity (0.73) of the product did not show significant changes, but was reported to increase significantly at a storage time of 60th day (0.83) (Pal and Agnihotri, 1994). There was constant increase in pH of chicken gizzard pickle (Sachdev *et al.,* 1994). On zero day pH of the pickle was 4.3 which increased to 4.8 at ambient storage, and 4.3 to 4.6 at refrigerated storage after 45 days. Initial pH (4.2) for chicken gizzard pickle changed marginally to 4.3 in both types of pouches (metalized polyester/polyethylene and polyethylene/polyamide/ ethylene acrylic acid films) and attained equilibrium value after 60 days of storage (Siddhu *et al.,* 1995). pH of pickled chicken meat reduced gradually from 5.81 on zero days to 4.66 on 80th day (Reddy and Rao, 1996).

On the day of preparation, pH and titratable acidity of chicken pickle was 4.85 and 1.10 which reached to 4.87 and 1.08 respectively (Shukla and Srivastava, 1999a). After maturation period of 8 days the pH of chicken pickle was stabilized to 4.84-4.85 thereafter increase in pH upto 90 days was negligible, titratable acidity was not significantly ($P<0.05$) affected by the addition of BHT and storage period (Shukla and Srivastava, 1999b).

pH of the boiled, boiled+fried rabbit meat pickle and boiled, boiled +fried rabbit liver pickle on day of preparation was 5.09, 4.85, 4.80, 4.94 which increased to 5.29, 5.19, 5.02, 4.95 respectively, on day 60 at ambient temperature storage respectively (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 while titratable acidity was increased from 1 to 1.1% at the end of six months (Khanna *et al.,* 2004). pH of papain and STTP treated spicy gizzard pickle showed decreasing trend but still it was significantly higher ($P<0.05$) than other variants on 60th day due to pH raising effect of phosphates (Grover *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).

b. TBARS value

Oxidation of lipids is one of the major causes of deterioration in the quality of meat and meat products and its quality. The thiobarbituric acid reacting substances (TBARS) value is used as an indicator of food quality and is highly correlated with rancidity and warm-over flavor (WOF) in muscle foods (Wilson *et al.,* 1976). The threshold value of TBA is 1-2 mg/kg for rancidity in meat (Watts, 1962). There was progressive increase in TBA values in pork pickle stored at ambient temperature. However, pickles treated with (BHT) antioxidant @ 200 ppm and packed in laminate had a lower TBA value (0.92 mg/kg) after 150 days of ambient storage as compared to those samples in HDPE (1.42 mg/kg) (Pal, 1990).

During storage, progressive increase in TBA value in chicken parts was reported by Reddy and Rao (1996). In fried chicken gizzard TBA increased significantly from 0.04 mg/kg at zero days to 0.11 mg/kg on 7th day and 0.15 mg /kg at ambient and refrigerated temperature respectively (Pangas *et al* 1998). TBA values in chicken gizzard pickles stored at room temperature increased from 0.3 mg/kg at zero day to 2 mg/kg on 45th day. (Sachdev *et al.,* 1994). Caprine keema prepared by using ascorbic acid 500 ppm, sorbic acid 500 ppm and nitrite 100 ppm had a TBA value of 1.48 mg/kg on zero day, which increased to 2.73 mg/kg on the 7th day (Karthikeyan *et al.,* 2000).

Iron catalyzed lipid oxidation is pH sensitive and is most active under acidic conditions (Liu, 1970) since, iron is maintained in ferrous state (Lee and Hendricks, 1997). pH and TBA values were reported to be negatively correlated (Aberle *et al.,* 1980). 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 1999a).TBA values of chicken pickle showed significant increasing trend with increase in storage time and addition of antioxidant BHT significantly reduced the rate of oxidation (Shukla and Srivastava, 1999b). TBA 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).

2. Microbiological quality and changes

The microbial growth in meat system depends upon several factors like moisture (aw), pH, salt content, availability of oxygen and storage temperature etc. In chicken meat pickle microbial count was reported to remain within safety limit even after 120 days of storage at ambient temperature (Chatterjee *et al.,* 1969*)*. Reduction in microbial count due to pickling has been reported in quail meat pickle. Aerobic, coliform and fungal counts were not detected up to 60 days of storage at both refrigerated (5±1^{o}C) and ambient temperature (Singh *et al.,* 1982). Quail pickle held under refrigeration (5±1^{o}C) had lower aerobic plate count (4.32 cfu/g) than those kept at 29 °C (4.60 cfu/g) up to a storage period of 150 days (Singh and Panda, 1984).

Even up to 120days of ambient storage pork pickles were reported to be free from *E. coli* although the initial total viable count, halophiles and yeast and mold in fresh meat were 5.75, 4.58 and 3.89 cfu/g respectively (Kumar and Bachhil, 1993). Pork pickle packed in HDPE had higher total aerobic mesophilic counts as compared to that of pickles packed in laminate. Pickles were reported negative for *Salmonella. Staphylococcus aureus* counts were also reported to be within the permissible limits even after storage period of 150 days at room temperature (Pal, 1990).On day zero standards plate count (4.14 cfu/g) and halophilic count (4.05 cfu/g) did not differed significantly even after a storage period of 60 days though it decreased to 3.75 and 3.80 cfu/g

in chevon pickles stored at room temperature. Yeast and mold counts were also reported to have remained below log 10/g throughout the storage period (Pal and Agnihotri, 1994).

Comparatively slow rate of microbial multiplication was reported in vinegar based gizzard pickle and the product remained microbiologically safe even after 75 days of storage during winter season (Sachdev *et al.,* 1994). In pickled chicken parts an increasing trend of total mesophilic count from log 1.431/ml on day zero to log 3.26/ml on 80th day of storage was observed (Reddy and Rao, 1996). Microbiological studies of shelf stable chicken pickle revealed that total plate count decreased from 4.67 cfu/g to 4.68 cfu/g at the end of 6 months, the product was free from *coliforms, Salmonella* and *S. aureus* throughout the storage period (Puttarajappa *et al.,* 1996). There was significant (P<0.01) increase in total aerobic mesophilic count from 3.42 cfu/g to 3.91 cfu /g, halophilic count from 3.25 cfu /g to 4.95 cfu/g on 90th day of storage (Shukla and Srivastava, 1999a). Addition of BHT was not fount to affect the total aerobic mesophilic count, halophilic count and yeast and mold count. However, along with the increasing storage significant (P<0.01) increase in all microbial counts was observed (Shukla and Srivastava, 1999b). Gradual but significant increase in total plate count was observed in specialty pickle of Nagaland. Antioxidant treated specialty pickle of Nagaland had lower (3.79 cfu/g) total plate count than control (4.23 cfu/g) on 90th day of ambient storage. Increase in halophilic count was reported on 30th day, which further declined by 90th day. (Khate, 2002).

The microbial counts of rabbit pickles remained in the range of 3 log cycle throughout the storage period. Standard plate count and halophilic counts did not vary significantly. (Sen and Karim, 2003). A gradual increase in bacterial counts of chicken pickle, regardless of packaging material was observed with storage time. The aerobic mesophilic counts were increased from 3.4 cfu/g to 3.9 cfu/g and 3.9 cfu/g in pickle stored in PET jars and laminated pouch respectively at the end of 6 months. (Khanna *et al.,* 2004). There was a significant increase in the aerobic mesophilic count during storage. Aerobic mesophilic count was unaffected by sodium ascorbate treatment, throughout the storage period of 90 days and count remained in the range of 3 log cycles (Gadekar *et al.,* 2008).

3. Sensory quality and changes

Quail pickled in solution containing 50% vinegar with either 8 or 10 % salt were more acceptable than those pickled in 75% solution, refrigerated stored pickle scored more than the pickle stored at room temperature. Along with the storage period the sensory scores declined significantly from 6.1-5.6 under both the storage conditions (Singh *et al.,* 1982). No significant differences in overall acceptability scores of pickled quail meat stored either at room or refrigeration storage was observed, but on 90th day of storage refrigerated stored pickle scored significantly higher than that stored at ambient temperature. The products were organoleptically acceptable upto 6 months under both the ambient and refrigerated storage (Singh and Panda, 1984).

Organoleptic scores for pork pickle were between good to very good for all recipes. As the level of back fat cubes increased from 25-50% the sensory scores declined (Padda *et al.,* 1985). There was some reduction in sensory scores of pork pickle after 60 days, overall acceptability reduced gradually but the extent of reduction was non-signifficant (Kumar and Bachhil 1993). Sensory attributes of the chevon pickle did not alter (score ranged 7.09-8.24) and product remained acceptable throughout the 60 days of ambient storage (Pal and Agnihotri, 1994).

The sensory evaluation of the pickle showed that the chicken pickle was acceptable even at the end of 6 months (Puttarajappa *et al* 1996). Slight reduction in colour, flavour and overall acceptance scores was observed as storage progressed, but even after 80 days of ambient storage, the pickled chicken parts were quite acceptable to panelists (Reddy and Rao, 1996). Non-significant decline in sensory characteristics of fried gizzard pickles upto 7 days at ambient storage period was observed, but the scores for colour, flavour, juiciness and overall acceptability were reported to be significantly lower as compared to fresh samples (Pangas *et al* 1998).

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, 1999a). Sensory attributes like, general appearance, texture, saltiness or sourness scores of poultry pickles were not significantly (P<0.05) affected by either by addition of BHT or with the increasing storage interval. The addition of BHT showed significant impact on the flavour score of the chicken pickle (Shukla and Srivastava, 1999b).

Sensory attributes of pickled guinea fowl meat were not affected by the packaging material and showed good to very good acceptability scores (Rana and Shukla, 2003). Significant reduction in

organoleptic scores of rabbit pickle was observed. However, the scores always ranged from good to very good throughout the storage period and product was highly acceptable up to 2 months. There was significant decline in flavour score of rabbit pickle during storage (Sen and Karim, 2003). During storage there was non-significant decrease colour of the chicken pickle up to 2 months in PET jars and 1 month in laminated pouches was observed. Similarly non-significant decrease in flavour up to 3 months in PET jar and 5 months in laminated pouches. Thereafter, decrease in colour and flavour score was significant (Khanna *et al.,* 2004). Incorporation of sodium ascorbate had significantly improved the sensory attributes of pickle especially appearance and flavour throughout the storage period (Gadekar *et al*., 2008).

Conclusion

Pickling of meat offers highly delicious and nutritious ready to eat shelf stable product with relatively longer shelf life and good market potential. It will also help to utilize meat from spent animals and process it into shelf stable convenience product. Pickle making will also provide better avenue for rural entrepreneurship development, due to lower initial cost of investment and non-requirement of refrigeration facility. Thus a meat pickle has good potential to capture market as ready to eat highly acceptable meat product and create self-employment opportunities for youths.

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