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INFLUENCE OF HOUSEHOLD COOKING METHODS ON STORAGE STABILTY OF VACCUM PACKAGED PORK PATTIES

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Abstract

The present investigation was carried out to evaluate the influence of various household cooking methods (boiling, hot air oven, pan frying and microwave oven cooking) on storage stability of vacuum packaged pork patties during refrigerated storage (4±1°C). Pork patties cooked by frying recorded significantly (P<0.05) higher pH and 2-thiobarbuteric acid reactive substance value (2-TBARS value) and patties cooked by microwave cooking had significantly (P<0.05) higher free fatty acid (FFA) values compared to other cooking methods. Pork patties cooked by boiling recorded significantly (P<0.05) lower total plate counts and total psychrophilic counts than other cooking methods. Fried patties recorded significantly (P<0.05) lower lactobacillus and yeast and mould counts compared to patties cooked by other cooking methods. Pork patties cooked by hot air oven cooking method scored significantly (P<0.05) higher colour scores than other cooking methods. A significant (P<0.05) higher flavor, juiciness, tenderness and overall acceptability scores were noted in patties cooked by boiling. Based on these results, it is concluded that pork patties cooked by boiling are less rancid and more microbial stable and rated superior sensory scores during refrigerated storage (4±1°C).

Keywords: Household cooking methods, Storage stability, Patties, Lipid oxidation.

Introduction

Cooking of meat is essential to achieve a palatable and safe product. Cooking methods applied to meat, improve its hygienic quality by inactivation of pathogenic microorganisms and enhance its flavour and palatability. The important adverse effect resulting from thermal treatment is lipid oxidation, a major reason for the deterioration of meat, giving undesirable odours, rancidity, texture modification, loss of essential fatty acids or toxic compound production (Alfaia *et al.* 2010). There are many factors that influence lipid oxidation, including the composition and content of triglycerides, and micro-components, such as antioxidants and metal ions (Ma *et al.* 2009). (However, for the controlled oxidation of any given lipid, the most

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important parameters are the thermal treatment conditions (temperature and time of cooking). When different household cooking methods were compared, roasting, which uses high temperatures for a long time, produces an increased lipid oxidation compared to other methods. However, microwave cooking using shorter time and lower temperature also promotes lipid oxidation. Frying is one of the oldest methods of food preparation and improves the sensory quality of food by formation of aroma compounds, attractive colour, crust and texture, but oils or fats can change the fatty acid composition of meat and suffer oxidation. Pork is particularly prone to oxidation due to its high PUFA content and its high concentration in free iron. Unsaturated fatty acids and especially polyunsaturated ones (PUFA) are highly susceptible to oxidation (Alfaia *et al.* (*loc.cit*)) thus oxidation reactions could be very important during thermal treatment and affect the properties of pork. A scanty information is available on the effect of various household cooking methods on quality of pork and pork products. Therefore, an investigation was carried out to evaluate the different household cooking methods on quality characteristics of vacuum packaged pork patties during refrigerated (4±1°C) storage.

Materials and Methods

Fresh lean meat (ham and loin) obtained from 12 months old of Large White Yorkshire cross breed of pig weighing about 90 kg and non-meat ingredients like salt, sugar, corn flour, refined sun flower oil, condiment and spice mix were procured from local market of Tirupati. The fresh lean meat cut into small chunks and minced in a meat mincer (Sirman, TC 12 E, Italy) through 4 mm plate. The emulsion was prepared by chopping the minced meat along with other non-meat ingredients in a bowl chopper (Scharfen, Model No: TC 11, Germany). The emulsion was prepared by using minced pork is mixed with salt @ 1.5 %, STPP @ 0.4 %, sodium nitrate @ 150 ppm, sodium ascorbate @ 500 ppm, sugar @ 1 % and ice flakes @ 8 % and chopped for one min followed by addition of oil @ 6 % and again chopped for one min and add corn flour @ 3 %, spice mix @ 1.6, condiment mix @ 3 % (onion and garlic: 3:1) and chopped for 3 min. The emulsion was taken for preparation of patties. 60 g of pork emulsion was taken for preparation of each raw patty and moulded in round flat shape by using 9.0 cm diameter and 1.2 cm height of bottom glass of petridish. The raw pork patties were subjected to different household cooking methods. In boiling cooking method, pork patties were sealed in LDPE packaging covers without any leakage and cooked in thermostat water bath maintained at 100 °C for 40 minutes. In hot air oven cooking method, patties were cooked in pre-heated electrical hot air oven to 180±5 °C for 30 minutes (15 min for each side of patties). In pan frying, patties were fried in pre heated (140°C) refined sun flower oil about 6 minutes

with frequent turnings. Microwave oven cooking at 1000 W for 4 min on each side of patty using microwave oven (LG, Multiwave, Model No: MC-806 AA, 1350 W, RF output: 850 W and Frequency: 2450 MHz) which were standardized in the department. In all cooking methods, the core temperature of the cooked patties was attained to 80±4 °C monitored by probe thermometer. The patties were cooled to room temperature (30±1 °C) and packaged in HDPE packaging covers by using vacuum package machine and stored at refrigerated (4±1 °C) temperature and evaluated for quality characteristics at 5 days interval up to 30 days.

The cooked pork patties were analyzed for various quality characteristics like pH (Trout *et al.* 1992), 2-Thiobarbituric acid reactive substance value (2-TBARS value) (Witte *et al.* 1970), per cent free fatty acids (Koniecko, 1979), microbiological profiles (APHA, 2005) and sensory evaluation (Keeton, 1983) where 8= extremely good and 1=extremely poor. The experiment was repeated three times and the samples were analyzed in duplicates and the data generated for different quality characteristics were compiled and analyzed by using SPSS Ver.16.

Results and Discussion

Influence of different household cooking methods on pH of vacuum packaged pork patties during refrigerated storage were presented in Fig 1. The pH of pork patties was significantly ($P<0.05$) affected by different cooking methods and fried samples recorded significantly ($P<0.05$) highest pH values and patties cooked by boiling and hot air oven methods noted lowest pH values throughout the storage period. The variations in pH might be due to differences in time taken for attainment of internal temperature in different cooking methods. Cooking caused significant changes in pH probably due to modifications of the electric charge of acid groups, separation of peptide chain and production of new compounds. Irrespective of cooking methods, pH values increased gradually as the storage period increased from 0 to 30^{th} day. This might be due to decomposition of nitrogenous compounds, production of basic components induced by the growth of bacteria and breakage of hydrogen bonds and electrostatic interactions in the proteins (Simeonidou *et al.* 1998). Different cooking methods and storage period significantly ($P<0.05$) influenced 2-TBARS values during entire storage period (Fig.2). Low 2-TBARS values was noticed in pork patties cooked by both boiling and hot air oven cooking. Pork patties cooked by frying and micro wave oven cooking methods noticed significantly ($P<0.05$) higher 2-TBARS values which might be due to frying promoted lipid oxidation, increasing malonaldehyde levels in fried oil

Fig. 1. Influenc of household cooking methods and storage period on pH of pork patties

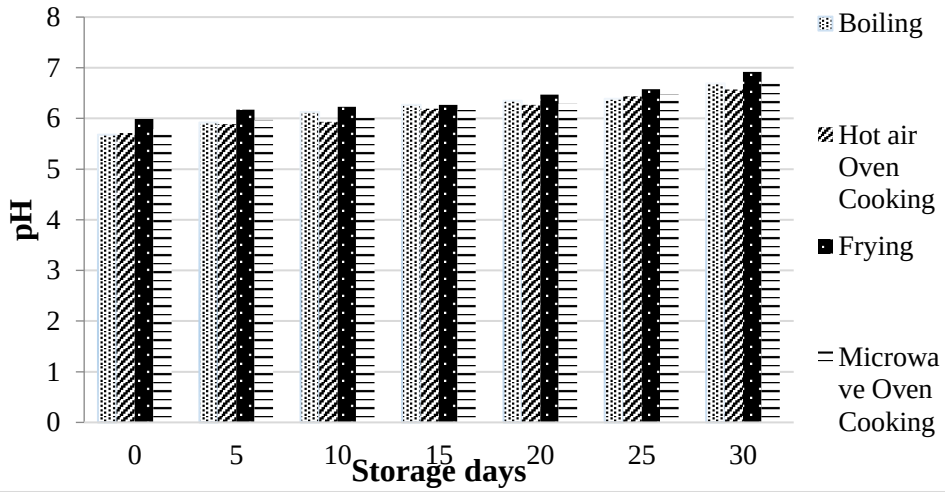


Fig.2. Influene of household cooking methods and storage period on 2-TBARS value of pork patties

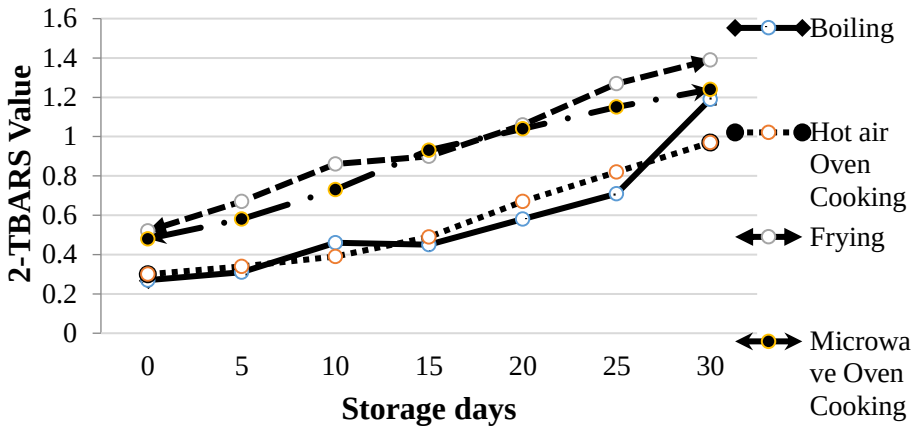
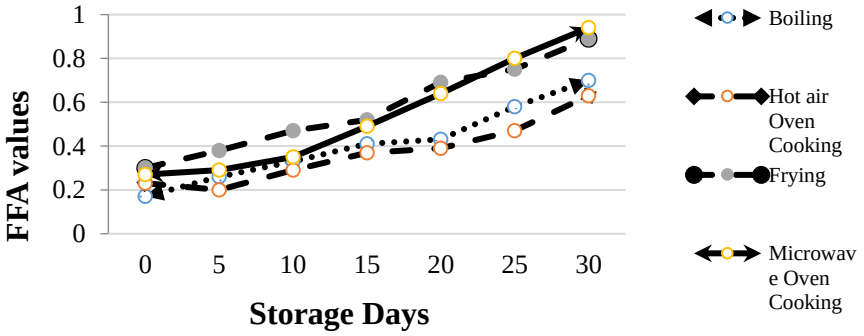


Fig. 3. Influence of household cooking methods and storage period on FFA of pork patties



i.e. sun flower oil and also in microwave oven cooking some interaction between microwave and meat fat which causes oxidation of polyunsaturated fatty acids. Further, cooking effect on the rate and extent of lipid oxidation of pork patties take into account that various factors associated with the thermal treatment itself (cooking methods, final cooking temperature or cooking rate) significantly varied in different cooking methods. These findings are in agreement with those reported by Weber *et al.* (2008) who described a higher oxidation in fried and microwave samples than in the roasted ones. Household cooking methods and storage period significantly ($P<0.05$) increased the free fatty acid (FFA) percentage during refrigerated storage (Fig.3). Pork patties cooked by microwave oven cooking significantly higher the FFA values than other cooking methods. Samples of triglycerides were heated in the presence of moisture, hydrolysis of esters led to liberation of FFA. Increase in FFA content during cooking to thermal hydrolysis coupled with destruction of cellular structure of meat. Microwave cooked samples undergo more thermal hydrolysis of fat due to greater hydrolytic effect of radiant microwave energy compared to other heating mechanisms. FFA values increased in all household cooked pork patties gradually and consistently during refrigerated storage. These results are in agreement with Lin *et al.* (2011) in minced pork.

The results revealed that the microbial counts of refrigerated stored pork patties cooked by different household cooking methods were comparable (Table 1). Pork patties cooked by boiling recorded significantly ($P<0.05$) lower total plate counts and total psychrophilic counts than other cooking methods which might be due to more penetration of moist heat subsequently killing of more number of microbes during boiling. Fried patties recorded significantly ($P<0.05$) lower lactobacillus counts and yeast and mould counts compared to patties cooked by other cooking methods. Refrigerated storage period also significantly ($P<0.05$) influenced total plate counts, total psychrophilic counts microbial counts of vacuum packaged pork patties cooked by different household cooking methods. As the storage period increased from 0 day to 30 days, the mean days of microbial counts increased gradually which might be due to conducive water activity and pH. Lactobacilli were shown to spoil vacuum packed meat products by causing off-flavour, discolouraton, gas formation and slime production**.** A similar trend of consistent increase of psychrotrophs bacterial counts during storage days in vacuum packaged minced goat meat during refrigerated storage was also reported by Babji *et al.* (2000).

Sensory scores for colour, flavour, juiciness, tenderness and overall acceptability of cooked pork patties influenced by different household cooking methods and storage period are presented in Table 2. Patties cooked by boiling followed by hot air oven cooking method

Table 1. Mean ± S.E values of microbial counts of vacuum packaged pork patties affected by different household cooking methods during refrigerated storage (4±1°C) *

Samples	Storage period (days)							Treatment Mean
	0	5	10	15	20	25	30	
Total plate count (log cfu/g)								
Boiling	2.29	3.06	3.28	3.50	3.81	4.05	4.70	3.53±0.16^{b}
Hot air Oven Cooking	2.17	2.90	3.41	3.71	3.90	4.26	4.61	3.57±0.52^{b}
Frying	2.30	3.19	3.59	3.62	3.89	4.20	4.83	3.66±0.28^{a}
Microwave Oven Cooking	2.25	3.02	3.34	3.84	4.01	4.38	4.97	3.69±0.35^{a}
Days Mean	2.25 ±0.24^{g}	3.04 ±0.63^{f}	3.41 ±0.19^{e}	3.67 ±0.32^{d}	3.90 ±0.30^{c}	4.22 ±0.27^{b}	4.78 ±0.42^{a}	
Lactobacillus count (log cfu/g)								
Boiling	1.19	1.26	2.08	2.12	2.48	2.69	3.07	2.13±0.17^{b}
Hot air Oven Cooking	1.27	1.30	1.72	2.31	2.75	2.92	3.24	2.26±0.30^{a}
Frying	1.13	1.41	1.59	1.90	2.27	2.41	2.85	1.94±0.52^{c}
Microwave Oven Cooking	1.20	1.35	1.69	2.07	2.31	2.83	3.18	2.09±0.09^{b}
Days Mean	1.20 ±0.15^{g}	1.33 ±0.49^{f}	1.77 ±0.17^{e}	2.10 ±0.39^{d}	2.45 ±0.67^{c}	2.71 ±0.23^{b}	3.09 ±0.13^{a}	
Total psychrophilic count (log cfu/g)								
Boiling	ND	2.29	2.46	2.89	3.09	3.57	4.03	3.06±0.27 ^{c}
Hot air Oven Cooking	ND	2.15	2.32	2.69	2.81	3.28	3.52	3.80±0.39 ^{a}
Frying	ND	ND	2.40	2.74	3.27	3.69	3.79	3.18±0.22^{b}
Microwave Oven Cooking	ND	ND	2.21	2.91	3.42	3.74	3.92	3.24±0.19^{b}
Days Mean	-	2.22 ±0.23^{f}	2.35 ±0.37^{e}	2.81 ±0.30^{d}	3.15 ±0.23^{c}	3.57 ±0.18^{b}	3.82 ±0.44^{a}	
Yeast and mould count (log cfu/g)								
Boiling	1.58	1.84	2.23	2.47	2.89	3.17	3.59	2.54±0.37^{a}
Hot air Oven Cooking	1.64	1.91	2.18	2.56	3.04	3.39	3.67	2.63±0.19^{a}
Frying	1.41	1.79	2.02	2.33	2.75	2.92	3.25	2.35±0.42^{b}
Microwave Oven Cooking	1.55	2.04	2.43	2.69	2.96	3.17	3.47	2.62±0.42^{a}
Days Mean	1.55 ±0.29^{g}	1.90 ±0.14^{f}	2.22 ±0.18^{e}	2.51 ±0.33^{d}	2.91±0.41^{c}	3.16 ±0.47^{b}	3.50 ±0.15^{a}	

Note: Mean values within row bearing different superscripts are differ significantly (P<0.05). * n=6

recorded significantly (P<0.05) higher sensory scores compared to the other cooking methods. As the progressing of storage period, the mean sensory scores were reduced gradually during refrigerated storage. This decline in colour scores encountered during storage could be due to non-enzymatic browning resulted from reaction between lipid oxidation products and amino acids. Reduced flavor scores might be due to the oxidation of fat as evident from TBARS values and liberation of free fatty acids as well as increased microbial load. The possible reason for decrease in overall acceptability during storage could be due to decline in flavour, colour and juiciness as a result of protein denaturation, lipid

Table 2. Mean ± S.E values of sensory attributes of vacuum packaged pork patties affected by different household cooking methods during refrigerated storage (4±1°C)*

Samples	Storage Period (days)							Treatment Mean
	0	5	10	15	20	25	30	
Colour								
Boiling	6.86	6.62	6.49	6.21	6.03	5.82	5.64	6.24±0.41^{b}
Hot air Oven Cooking	7.18	6.94	6.78	6.43	6.18	5.96	5.70	6.45±0.12^{a}
Frying	6.72	6.70	6.42	6.27	6.12	5.82	5.61	6.24±0.17^{b}
Microwave Oven Cooking	6.95	6.82	6.67	6.40	6.24	6.02	5.73	6.40±0.51^{a}
Days Mean	6.93 ±0.18^{a}	6.77 ±0.29^{b}	6.59 ±0.21^{c}	6.33 ±0.45^{d}	6.14 ±0.32^{e}	5.91 ±0.12^{f}	5.67 ±0.27^{g}	
Flavor								
Boiling	6.71	6.57	6.38	6.20	6.02	5.81	5.75	6.21±0.21^{a}
Hot air Oven Cooking	6.84	6.52	6.24	6.13	5.94	5.72	5.68	6.18±0.17^{a}
Frying	6.92	6.43	6.12	5.97	5.85	5.74	5.61	6.09±0.40^{b}
Microwave Oven Cooking	6.53	6.32	6.27	6.09	5.89	5.70	5.53	6.05±0.09^{b}
Days Mean	6.75 ±0.16^{a}	6.46 ±0.12^{b}	6.25 ±0.31^{c}	6.10 ±0.37^{d}	5.93 ±0.33^{e}	5.74 ±0.25^{f}	5.64 ±0.20^{g}	
Juiciness								
Boiling	7.06	6.92	6.81	6.67	6.42	6.25	6.06	6.59±0.43^{a}
Hot air Oven Cooking	6.85	6.79	6.58	6.43	6.23	6.03	5.83	6.39±0.51^{b}
Frying	6.51	6.43	6.21	6.07	5.91	5.75	5.52	6.06±0.27^{d}
Microwave Oven Cooking	6.72	6.56	6.42	6.25	6.12	5.92	5.73	6.25±0.33^{c}
Days Mean	6.79 ±0.27^{a}	6.68 ±0.19^{b}	6.51 ±0.41^{c}	6.36 ±0.34^{d}	6.17 ±0.28^{e}	5.99 ±0.33^{f}	5.79 ±0.44^{g}	
Tenderness								
Boiling	7.06	6.84	6.43	6.28	6.03	5.91	5.75	6.33±0.33^{a}
Hot air Oven Cooking	6.93	6.75	6.53	6.24	5.89	5.72	5.59	6.24±0.19^{a}
Frying	6.36	6.24	6.03	5.85	5.67	5.46	5.21	5.83±0.17^{c}
Microwave Oven Cooking	6.73	6.49	6.28	6.17	5.92	5.70	5.39	6.10±0.28^{b}
Days Mean	6.77 ±0.13^{a}	6.58 ±0.40^{b}	6.32 ±0.35^{c}	6.14 ±0.24^{d}	5.88 ±0.19^{e}	5.70 ±0.55^{f}	5.49 ±0.30^{g}	
Overall acceptability								
Boiling	7.17	6.93	6.70	6.49	6.27	6.06	5.76	6.48±0.25^{a}
Hot air Oven Cooking	6.92	6.76	6.59	6.33	6.02	5.86	5.44	6.27±0.41^{b}
Frying	6.78	6.61	6.45	6.29	5.98	5.76	5.32	6.17±0.33^{c}
Microwave Oven Cooking	6.85	6.52	6.37	6.11	5.86	5.67	5.44	6.12±0.09^{c}
Days Mean	6.93 ±0.45^{a}	6.71 ±0.24^{b}	6.53 ±0.37^{c}	6.31 ±0.27^{d}	6.03 ±0.29^{e}	5.84 ±0.11^{f}	5.49 ±0.39^{g}	

Note: Mean values within row bearing different superscripts are differ significantly ($P<0.05$). * n=18

oxidation and dehydration of the meat products. This is in accordance with Rajkumar *et al.* (2004) who found decrease in overall acceptability of meat products during refrigerated storage.

Conclusion

From the above results, it is concluded that pork patties cooked by boiling and adopting vacuum packaging method had less lipid oxidation and more microbial stability and rated superior sensory scores throughout refrigerated storage compared to hot air oven cooking, pan fried and microwave cooked pork patties and also health beneficial to consumers.

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