J.Meat Sci., 2012, 8(1&2) : 49 - 53 Research Paper

Studies on Nutritive Quality of Fermented Pork Sausages Stored at Ambient Temperature

Pantawane, P., R.J. Zende*, A.M. Paturkar, D.M. Chavhan and Nagappa, K.

Department of Veterinary Public Health, Bombay Veterinary College, Parel, Mumbai - 400 012.

ABSTRACT

The sausages fermented with *Pediococcus pentosaceus* and Glucono-delta-Lactone were analyzed for their nutritive quality attributes. Each group of sausages was further divided into four categories depending upon use of type of casings. Thus T_1 and T_2 category of sausage were prepared using bacterial culture & natural casing and, bacterial culture & synthetic casing, respectively, while T_3 & T_4 category of fermented pork sausage were prepared using GdL & natural casing, and GdL & synthetic casing, respectively. A total of 196 sausage samples were evaluated on every 15 days interval upto 90 day to study nutritive quality at ambient storage temperature of 32.2-35.1^{0}C. The study revealed that moisture content of all fermented sausages showed a constant reduction during the storage period in all the treatments while fat, protein and ash contents were found to be increased with storage period. No significant difference was observed within all the treatments throughout the ambient storage period.

Key words: *Ambient storage, fermented pork sausages, Glucono-delta-Lactone, nutritive quality, Pediococcus pentosaceus.*

INTRODUCTION

Meat is well known as an excellent protein and energy source for our daily diets and after digestion, provides excellent nutrition especially protein, B vitamins, iron and zinc (Chang and Huang, 1991). In most countries, meat consumption increases as economic development improves (Fuller, 1996). Meat is an excellent source of many nutrients, as a nutrient dense food, meat provides major nutritive contributions to diet relative to the amount of calories it contains. For example, a 3 ounce cooked portion of lean beef containing 195 calories would provide 25 g of protein, 9 g of fat, over one-third of your daily requirement for zinc and nearly 15% of your daily iron needs (Boyle, 1994). Sausages as processed meat products are very common and popular that manufactured from lower value trimmed meat to produce a higher-value product. The word sausage originates from the Latin word “salsus”, which means salted or preserved or chopped minced meat preserved by salting (Forrest *et al*., 1975). USDA meat inspection committee classified sausages as fresh, uncooked smoked, cooked smoked, cooked dry, semi dry, luncheon meat, loves and jellied product. Sausages are more economical when it is manufactured from cheaper cuts of meat and animal by-products (Pearson and Gillet, 1996).

Today, the world faces the problem of shortage of food supply, which makes the malnutrition problem and its consequences in the undeveloped countries a major problem (Sheehy *et al*., 2005). Between 2007 and 2011, per capita consumption of meat increased by 10%, meat consumption is the highest in developed country, in which the average per capita consumption is 78.3 kg/person per year. In developing country including India, the per capita consumption average is 32.2 kg/ person per year. People in world consume 42.1 kg/ person per year (FAO, 2011).

Research’s are limited on fermented sausage in Indian Literature, research on nutritional

*Corresponding author, e-mail: ravindrazende@gmail.com

information on fermented sausages revealed some food composition information. But there are no studies carried on the nutritional value of these products.

MATERIALS AND METHODS

Sample collection: Fermented pork sausages prepared using bacterial culture (*Pediococcus pentosaceus*) and chemical agent (Glucono-delta-Lactone) under the ICAR sponsored research project entitled "AICRP on Post Harvest Technology" and implemented in the department of Veterinary Public Health, Bombay Veterinary College, Mumbai were collected for the evaluation of nutritional quality. The fermented pork sausage samples were prepared in two major groups such as one group of sausage prepared using bacterial culture *viz, Pediococcus pentosaceus* and another group of sausage prepared using GdL (Glucono-delta-Lactone). Each group of sausages was further divided into four categories depending upon use of type of casings. Thus T_1 and T_2 category of sausage were prepared using bacterial culture & natural casing and bacterial culture & synthetic casing, respectively. Similarly T_3 & T_4 category of fermented pork sausage were prepared using GdL & natural casing, and GdL & synthetic casing, respectively. All the sausages were stored in well ventilated room at ambient storage temperature. A total of 196 sausages samples were evaluated at seven different occasions. The sausage prepared without culture and GdL served as a control. The sausage samples were analyzed on every 15th day interval upto 90 day; however control sample get spoiled after 24 hr of storage thus not analyzed thereafter.

The moisture, crude protein, ash and fat contents of fermented pork sausages were determined as per the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

***Moisture*:** Around 10 g accurately weighed sausage sample was placed in hot air oven at 100±1°C for 16-18 h. After cooling it in desiccator for 10 min, the loss of moisture was determined and expressed as percent moisture of sample.

***Fat*:** Accurately weighed slices of sausage samples in thimbles were dried overnight at 50°C in hot air oven. The fat was extracted with petroleum ether (BP 60-80°C) in Soxhlet's apparatus.

***Protein*:** Nitrogen content of samples was estimated by the Kjeldahl method and protein content was expressed by multiplying the nitrogen value with constant factor 6.25 and taken as the crude protein content in the sample.

***Ash*:** 5 g of sausage sample weighed in dry silica crucible was ignited at temperature of 600^{0}C in muffle furnace until ash was free from carbon.

Statistical analysis

The data generated for different quality characteristics during the experiment were compiled and analyzed by Randomized Block Design within the treatments on each day of storage by using software "WASP- Web Agree Stat Package- 2.0" developed at ICAR research complex, Goa.

RESULTS AND DISCUSSION

All the four categories of sausages were evaluated on 0, 15, 30, 45, 60, 75 and 90 days of ambient storage for proximate analysis by following standard method of AOAC (1995) and the results are presented in Table 1.

***Moisture*:** The moisture content of control, T_1, T_2, T_3 and T_4 on 0 day were observed as 33.44±1.99, 33.21±2.27, 33.86±1.97, 33.00±2.59 and 33.93±1.96, respectively. The moisture content was found to be decreased on each subsequent storage interval up to 90 day of ambient storage to the level of 11.13±2.42, 11.27±2.39, 12.21±0.99 and 12.43±2.31 in T_1, T_2, T_3 and T_4, respectively. The moisture reduction was more in sausages prepared with natural casing as compared to sausages prepared with synthetic casing. No significant difference was observed for moisture content of control, T_1, T_2, T_3 and T_4 on 0 day and also within treatments throughout the storage interval. The value of moisture on 0th day was in close agreement with standard value prescribed by Heinz and Hautzinger (2007) for raw fermented

Table 1: Proximate composition of pork sausages fermented by *Pediococcus pentosaceus* culture and GdL and stored at ambient temperature (32.2 – 35.1^{0}C) (Mean±SD)

Treatment	Proximate Component (%)	Average proximate components observed at different ambient storage interval (%)						
		0 day	15 day	30 day	45 day	60 day	75 day	90 day
Control	Moisture	33.44±1.99	ND	ND	ND	ND	ND	ND
	Fat	41.24±1.01	ND	ND	ND	ND	ND	ND
	Protein	22.82±4.29	ND	ND	ND	ND	ND	ND
	Ash	4.80±0.49	ND	ND	ND	ND	ND	ND
T_1	Moisture	33.21±2.27	20.32±1.46	17.42±1.26	13.99±3.62	12.33±3.44	11.74±3.28	11.13±2.42
	Fat	41.07±1.80	42.18±4.61	42.36±1.71	42.61±2.26	43.51±1.91	43.80±3.04	43.86±3.00
	Protein	21.25±1.21	21.30±0.62	21.46±0.66	21.60±1.23	21.61±0.91	21.64±1.30	21.68±1.64
	Ash	4.74±0.48	4.74±0.32	4.76±0.20	4.88±0.45	4.92±0.85	5.02±1.14	5.07±1.30
	Moisture	33.86±1.97	19.74±1.57	18.39±1.08	14.78±2.71	12.73±2.12	12.02±2.30	11.27±2.39
	Fat	40.88±1.12	43.24±3.60	43.84±3.32	44.65±5.34	44.76±4.50	44.88±4.08	45.67±2.13
	Protein	20.87±1.22	21.10±1.08	21.40±1.25	21.58±1.51	21.60±1.56	21.62±1.41	21.70±1.56
	Ash	4.50±1.02	4.75±0.99	4.85±0.71	4.86±0.92	4.89±1.05	4.91±1.02	4.97±1.02
	Moisture	33.00±2.59	19.85±0.83	17.35±1.13	14.12±4.19	13.79±2.09	12.32±2.03	12.21±0.99
	Fat	40.86±2.99	42.75±4.08	44.11±3.30	44.84±4.50	44.96±3.21	45.08±2.83	45.13±1.98
	Protein	20.49±0.81	20.80±1.24	21.12±1.31	21.22±1.40	21.63±0.97	21.89±1.41	21.91±1.47
	Ash	4.60±4.83	4.71±0.83	4.80±0.78	4.93±1.20	4.95±1.43	4.98±0.74	5.09±1.04
	Moisture	33.93±1.96	19.99±0.72	18.32±0.71	15.20±2.80	14.07±2.05	12.47±2.93	12.43±2.31
	Fat	39.88±1.28	42.39±5.53	42.73±3.91	44.07±5.65	44.55±2.61	44.78±4.17	44.84±3.61
	Protein	20.64±1.02	21.14±0.79	21.18±0.58	21.41±0.72	21.53±1.00	21.77±0.90	21.87±0.90
	Ash	4.61±0.95	4.67±0.91	4.73±1.84	4.77±0.79	4.77±0.96	4.92±0.78	4.94±1.25

Means in the same column are not differ significantly. Note: ND- Not Done; GdL-Glucono-delta-Lactone ; T_1-*Pediococcus pentosaceus* culture with natural casings; T_2- *Pediococcus pentosaceus* culture with artificial casings; T_3- GdL with natural casings; T_4- GdL with artificial casing

sausage (33.9%) and Jay (1992) stated that drying sausages contain 30-40% moisture. In present study rapid decline in moisture was observed during different storage interval it might be due to effect of dehydration (Mukharjee *et al.*, 2006). The results are in agreement with Mukharjee *et al.* (2006) who reported initial moisture content of 61.2% reduced to 33.9-37.8% in goat meat dry sausage fermented at 30^{0}C. Ceylon and Fung (2000) found moisture content of 59.9% decreased to 37.8% in Turkish sausages fermented with *Pediococcus acidilactici* while in present study initial moisture content ranged from 33.21±2.27-33.93±1.96 decreased to 11.13±2.42-11.27±2.39. The reduction in moisture content is more as compared to above research findings.

Fat: The fat content in fermented pork sausages analyzed found to be increased throughout the storage period interval upto 90 day with average values 43.86±3.00, 45.67±2.13, 45.13±1.98 and 44.84±3.61 for T_1, T_2, T_3 and T_4 sausage samples, respectively. No significant difference was found among all treatments and control on 0 day and between treatments within storage period. The value of fat observed in the study was higher than reported by Heinz and Hautzinger (2007) for raw fermented sausages and Comi *et al.* (2004) for naturally fermented sausage (27- 35%) and Zivkovic *et al.* (2012) in Sremska sausages. Similar finding of increased in fat with increase in storage was also recorded by Papadima and Bloukas (1999) in Greek sausages.

***Protein*:** The protein content of control, T_1, T_2, T_3 and T_4 sausage samples on 0th day observed were 22.82±4.29, 21.25±1.21, 20.87±1.22, 20.49±0.81 and 20.64±1.02, respectively. The protein content of all the sausage samples of all the treatment groups showed slight increasing trend upto the end of storage and the values on 90 day reported as 21.68±1.64, 21.70±1.56, 21.91±1.47 and 21.87±0.90 for T_1, T_2, T_3 and T_4, respectively. No significant differences were observed for protein content of control and sausages of all treatments on 0 day and throughout the storage period between the treatments. The values obtained for protein content in present study are similar to the study carried out by Comi *et al.* (2004) and Malti *et al.* (2009) who reported protein content was around 20% in naturally fermented sausages and camel meat fermented sausages, respectively. Kirupasanker *et al.* (2007) observed increase in protein content as storage period advanced and reported mean value on 6th day as 25.94±0.09 in fermented chicken sausage.

***Ash*:** The average ash value for control, T_1, T_2, T_3 and T_4 observed on 0 day was 4.80±0.49, 4.74±0.48, 4.50±1.02, 4.60±4.83 and 4.61±0.95, respectively. With increasing storage period all the treatment sausages showed increasing trend till the end of storage. The values observed on 90th day were 5.07±1.30, 4.97±1.02, 5.09±1.04 and 4.94±1.25 for T_1, T_2, T_3 and T_4, respectively. No significant difference was found among all treatments and control on 0 day and between treatments and during different storage interval. The value of ash observed in the present study was slightly higher than reported by Heinz and Hautzinger (2007) for raw fermented sausages (3.8) and lower than value observed by Predrag *et al*. (2010) for *Petrovska Klobasa* (3.87-5.26 %) and Rai *et al*. (2010) in dry fermented Chinese-style sausage added with pure starter culture at the end of ripening (7.2±0.21).

The moisture content of all fermented sausages showed a constant reduction during the storage period in all the treatments while fat, protein and ash content were increased with increase in storage period. No significant difference was observed within the treatments throughout the storage. Kirupasankar *et al.* (2007) also found significant decrease in moisture content with increase in protein, fat and ash contents with advancement of storage in chicken sausage fermented with *Pediococcus cerevisiae* stored at ambient temperature. Similarly, Ceylon and Fung (2000) observed decrease in moisture content with increase in fat, protein and ash with advancement of period in Turkish dry sausage produced with addition of *Pediococcus acidilactici.*

This decrease in the moisture content might be due to high environmental temperature and effect of drying as all sausages prepared were stored in well ventilated room at ambient storage temperature (32.2-35.1^{0}C) recorded during study. Zivkovic *et al*. (2012) stated reduction in moisture content is directly proportional to the storage and drying temperature and also due to the higher fat content in the product. Vignolo *et al.* (2008) reported fermented sausages should have 2:1 moisture protein ratio, resultant decrease in moisture content will increase the protein percent of final product. Kandeepan *et al.* (2010) found fat content was closely and inversely related to the moisture level of the product. This could explain the percent increase in protein, fat and ash with reduction in moisture in the product. The high ash content was possibly resulted from salt and other additives added because of their dehydrating effect. These findings are in accordance with Visessanguan *et al.* (2005) who found ash content increased with storage in Thai fermented pork sausage as effect of added additives and salt.

CONCLUSION

Based on above findings, it can be concluded that the moisture contents of all the fermented pork sausages were found to be decreased while protein, fat and ash content were increased with advancement of ambient storage period, However, no significant difference was found in the nutritional composition of both the groups.

ACKNOWLEDGEMENT

The research grants and facilities provided by the Indian Council of Agricultural research (ICAR)

New Delhi under AICRP on Post Harvest Technology is hereby thankfully acknowledged.

REFERENCES

AOAC (1995) Official Methods of Analysis, 15thedn. Association of Analytical Chemists, Washington, DC.

Boyle E (1994) Identifying Sausages, Department of Animal Sciences and Industry, Kansas State University. http://www.oznet.ksu.edu/meatscience/Topics.htm

Ceylon E, Fung DYC (2000) Destruction of *Yersinia enterocolitica* by *Lactobacillus sake* and *Pediococcus acidilactici* during Low-temperature fermentation of Turkish Dry Sausage (sucuk). J food Sci 65: 876-889.

Chang SF, Huang, TC (1991) Some parameters involved in production of Zousoon—A semi-dry, long fibered pork product. Meat Sci 30: 303-325.

Comi G, Urso R, Lucilla I, Kalliopi R, Patrizia C, Carlo C, Luca C (2004) Characterization of naturally fermented sausages produced in the North East of Italy. Meat sci 69: 381-392.

FAO (Food outlook-November) (2011) Global market analysis, Meat and Meat Products market summary. http://www.fao.org/docrep/014/al981e/al981e00.pdf.

Forrest JC, Aberle ED, Hedrick HB, Judge MD, Morkel RA (1975) Principles in meat science, WH Freeman and Company, San Francisco. pp-17.

Fuller F (1996) U.S. meat export analysis and trade news. Meat Export Research Center. Iowa State University. Ames. IA. 4: 1-5.

Heinz G, P Hautzinger (2007) Meat processing technology: For small-to medium-scale producers, RAP publication (FAO, 2007) pp 2-3.

Jay JM (1992) Modern Food Microbiology. New York: Chapman and Hall. pp. 374- 384.

Kandeepan G, Anjaneyulu ASR, Kondaiah N, Mendiratta (2010) Quality of buffalo meat keema at ambient storage temperature. Afr J Food Sci 4: 410-417.

Kirupasankar M, Pandey NK, Yadav AS (2007) Ambient shelf life of chicken sausages fermented with *Pediococcus cerevisiae*. Indian J Poult Sci 42: 273-276.

Malti Jazila EI, Amarouch H (2009) Microbiological and physico-chemical characterization of the natural fermented camel meat sausage. Afric J Biotechnol 8: 4199-4206.

Mukharjee R, Chowdhury B, Chakraborty R, Chaudhuri (2006) Effect of fermentation and drying temperature on the characteristics of goat meat (Black Bengal variety) dry sausage. Afric J Biotechnol 5: 1499-1504.

Papadima SN, Bloukas JG (1999) Effect of fat level and storage condition on quality characteristics of traditional Greek sausages. Meat sci 51: 103-113.

Pearson AM, Gillet TA (1996) Processed Meats, 3rd edn. CBS Publishers and Distributors, New Delhi, pp: 57-77.

Predrag MI, Petrovic LS, Ljiljana TA, Dzinic RN, Jokanovic RM, Tomavic MV (2010) Physicochemical, biochemical and sensory properties for the characterization of *Petrovska klobasa* (traditional fermented sausage). APTEFF 41: 1-203.

Rai KP, Wen-shui X, Chun-hui Z (2010) Effects of pure starter cultures on physico-chemical and sensory quality of dry fermented Chinese-style sausage. J Food Sci Technol 47:188–194.

Sheehy JE, Elimido A, Genteno G, Pablico P (2005) Searching for new plants. For climate change. J Agric Meteorol 60: 463-468.

Vignolo G, Fontana C, Fadda S (2008) Semidry and dry fermented sausages. In Handbook of meat processing. Edt by Fidel Toldra. Wiley-Blackwell, A John wiley and sons, INC, Publication. pp 379-381.

Visessanguan W, Benjakul S, Panya A, Kittikun C, Assavanig A (2005) Inûuence of minced pork and rind ratios on physico-chemical and sensory quality of Nham – a Thai fermented pork sausage. Meat Sci 69: 355–362.

Zivkovic D, Radulovic Z, Aleksic S, Perunovic M, Stajic S, Stanisic N, Radovic C (2012) Chemical, sensory and microbiological characteristics of Sremska sausage (traditional dry-fermented Serbian sausage) as affected by pig breed. Afric J Biotechnol 11: 3858-3867.