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Chandan Kumar Sahu
Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Subhash Kumar Verma
Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Keshab Das
Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Anil Patyal
Department of Veterinary Public health and Epidemiology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Rahul Pendro
Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Corresponding Author:
Subhash Kumar Verma
Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh, India

Microbiological evaluation of most preferred meat and value-added meat products in Durg District of Chhattisgarh India

Chandan Kumar Sahu, Subhash Kumar Verma, Keshab Das, Anil Patyal and Rahul Pendro

Abstract
The present study was conducted in Durg district of Chhattisgarh to assess hygienic outlook of consumers through contact survey studies. The district was divided in three zones and 200 respondents from each zone were selected purposively to constitute a total sample size of 600 respondents for the study and two indices based on questions were constructed. The findings indicate microbial load from fresh meat differed significantly amongst zones. Standard Plate Count was observed in between three zones and irrespective of zone of sampling a non-significant (p>0.05) variation was observed in raw meat samples and value added meat sample (Chicken curry) between all three zones. Coliform count was observed in raw meat and value added meat samples (chicken curry) between all three zones was found to have non-significant variation (p>0.05). It was concluded that for the success of meat processing sector, consumers need to be aware, educated about processing pattern and value addition in meat products.

Keywords: questionnaire, raw meat, meat products, standard plate count, coliform

Introduction
Chhattisgarh is rich in livestock wealth. In 2019, State had 99.83 lakh cattle, 11.74 lakh buffaloes, 40.04 lakh goats, 1.80 lakh sheep, 5.26 lakh pigs, and 187.12 lakh poultry birds. In Durg district there are 10877 Exotic cattle and 296816 Indigenous (Desi) cattle, 51122 buffaloes, 61499 goats, 7472 sheep and 1594 pigs available. (Livestock Census, 2019) [21].

Meat is mainly composed of water, fat and also is a good source of protein, vitamins and minerals, such as iron, selenium, zinc and vitamin B-complex. It is also one of the main sources of vitamin B12 and is usually eaten together with other food but is normally eaten after it has been cooked and seasoned or processed in a variety of ways. Unprocessed meat will get spoilt within hours or days as a result of infection with decomposition by bacteria and fungi (Truswell, 2002) [33].

Meat and meat products are highly perishable commodities and hence, they should be properly stored, processed, packed and distributed in order to prevent microbial growth (Heetun *et al.*, 2015) [13]. The level of microorganisms present in meat products can be reduced only when they are further processed (Jay *et al.*, 2005) [19]. If spoilage microorganisms such as *Brochothrix thermosphacta* and *Pseudomonas spp*. are present and grow to a high number, the meat will be spoilt and will be unfit for human consumption (Davies and Board, 1998) [7]. Pathogens, such as *Aeromonas hydrophila*, *Bacillus cereus*, *Campylobacter jejuni*, *Clostridium perfringens*, *Escherichia coli*, *Listeria monocytogenes*, *Salmonella spp*., *Staphylococcus aureus* and *Yersinia enterocolitica* can also grow and cause illness either by multiplication in the human body (food infection), producing toxins (food intoxication) or multiplying and releasing toxins in the body (food toxico-infection). The presence of pathogens in the food supply is considered to be undesirable as they are the major cause of gastrointestinal disease throughout the world. (Hotee, 2011) [15].

Meat is not only highly susceptible to spoilage, but also frequently implicated in the spread of food borne illness. Contaminated raw meat is one of the main sources of foodborne illness (Bhandare *et al.*, 2007; Podpecan *et al.*, 2007) [4], [29]. During slaughter and processing, all potentially edible tissues are subjected to contamination from a variety of sources within and outside animal. In living animals, those surfaces in contact with the environment harbor a variety of microorganisms.

The contaminating organisms are derived mainly from the hide of the animal and also comprise organisms that originate from feces also. In addition, processed meat foods are more prone to contamination with pathogenic microorganisms during the various stages of processing. Meat and meat products are important sources of human infections with a variety of foodborne pathogens, i.e. *Salmonella spp*., *Campylobacter jejuni*, *Yersinia enterocolitica*, verotoxigenic *Escherichia coli* and to some extent *Listeria monocytogenes*. Some pathogens in meats (eg. *Salmonella spp*., *Campylobacter spp*.) are most efficiently controlled by the main interventions applied in the primary production combined with the optimization of the slaughter hygiene. For organisms like *Listeria monocytogenes*, *Staphylococcus aureus* and *Clostridium spp* the main control measures are focused on later stages of the meat chain (Norrung *et al*., 2009) [23]. The high prevalence of diarrheal diseases in many developing countries suggests major underlying food safety problems. These food items can cause serious problems when they are contaminated with harmful microorganisms due to lack of proper sanitary condition, hygiene practices, and proper storage and mishandling (WHO, 2009) [34]. Due to unawareness and non-enforcement of laws often consumers buy meat and meat product that fails to protect consumers right and possess a potential risk.

Food is a highly perishable commodity as it easily gets spoiled by various types of organisms. Raw meat and other meat products can act as vehicles of various hazards that may have serious impact on human health. There are various types of hazards which may be chemical, biological or physical. Biological hazards are of concern because the microorganisms or pathogens are found naturally in the environment or even on live animals (Sofos, 2014) [31]. Therefore, the occurrence of pathogens on raw meat can be due to different factors which include poor farm animal management, improper slaughter practices, processing, storage conditions and lack of meat safety knowledge among meat handlers (Marais *et al.*, 2007) [25]. The consumer needs to be provided with safe and wholesome meat which will not cause any health problem. This can be achieved by practicing better farm animal management, good personal hygiene and providing adequate knowledge on food safety to all the meat handlers in the production chain (Haileselassie *et al.*, 2013; Sofos, 2014) [11], [31].

Materials and Methods

All the bacteriological media, chemicals and reagents used in the present study were obtained from Hi-Media, India, Thermo Scientific, USA and Bangalore Genei, India. Prepared according to the instructions provided by the manufacturing firms and were checked for sterility before use. Autoclave (Obromax), Deep freezer (Remi), Electronic balance (Sartorious), Hot air oven (Unitech), Incubator (Mac), Laminar flow (Microfilt), Micropipette (Borosil), Refrigerator (LG), Ultra low temperature freezer (Remi), Test tubes (Borosil), Petridish (Borosil), Beaker (Borosil), Funnle (Borosil), Vortex mixer (Mac) etc. were used during the course of present study.

Sample collection

The most preferred meat and value-added meat products (Raw chicken and chicken curry) were collected from different zones of district Durg during the study. Each zone represents a block of the district namely zone I represents Durg block, zone II Patan block and zone III Dhamdha block respectively. The samples were collected following the protocol recommended by Anon (1978) [1]. Raw chicken and chicken curry samples were collected in sampling boxes aseptically and transported to the laboratory under chilled condition for analysis within 4-6 hrs.

Experimental details

Microbiological Analysis

Standard Plate Count and Total Coliform count of the samples were enumerated following the methods as described by American Public Health Association (APHA 1984)[2].

Statistical analysis

Data were analyzed statistically using "SPSS (25)" software package as per standard methods. Qualitative data were analyzed by Chi-Square test. For microbiological analysis, duplicate samples were drawn for each parameter in each zone. The mean values were reported along with standard error. The statistical significance was estimated at 5% level ($p<0.05$) and evaluated with one way ANOVA.

Results and Discussion

Evaluation of the microbiological quality of meat and value-added meat product samples from various sources.

A total of 18 samples (9 raw and 9 value added) were collected from different roadside vendors and various villages from three different zones of Durg district and processed for microbial counts (Standard plate count and coliform count) for raw meat (chicken meat) and value-added meat (chicken curry) samples are presented in Table 1,2,3 and 4.

During the present study mean value of Standard Plate Count (SPC) was 5.766±.4055 to 6.066±.3179 $\log_{10}$ cfu/g in between three zones and irrespective of zone of sampling a non-significant ($p>0.05$) variation was observed in raw meat samples between all three zones (Table 1). The value of SPC in raw meat indicates marginally contamination in all three zones as per FSSAI (2011) [8]. This finding was in accordance to the earlier experiment of Parvin *et al.* (2017) [28] who reported mean value of TVC (Total Variable Count) in raw meat 5.24±0.42 $\log_{10}$ cfu/g, Chakraborty (2020) [5] reported TVC of 5.9292±0.0565 $\log_{10}$ cfu/g in chicken raw meat and in contrast to present finding Higenyi *et al.* (2014) [14] found lower count 4.49 $\log_{10}$ cfu/g in minced raw meat, Hanyinza *et al.* (2020) [12] found lower count (<4 Log_{10} cfu/g) in beef samples. Comparatively higher SPC count of 6.18 ± 0.67, 7.05±0.78 and 6.374 $\log_{10}$ CFU/g in chicken meat, beef samples and chicken meat sample were reported by Ibrahim *et al.* (2015) [16], Zulfakar *et al.* (2017) [36] and Beigh *et al.* (2019) [3] respectively. Wide variations in the SPC values may occur due to differences in sampling methods, sampling sites, handling, and modes of evaluation, climatic conditions, fecal contamination and lack of cleanliness on the retail outlets of meat or slaughter house (Nikas, 2009) [22].

The mean value of Standard plate count (SPC) was 3.000±.1154 to 3.466±.4409 $\log_{10}$ cfu/g in between three zones and irrespective of zone of sampling a non-significant ($p>0.05$) variation was observed in value added meat samples (Chicken curry) between all three zones (Table 2). The value of SPC in value added meat indicates marginally contamination in all three zones as per FSSAI (2011) [8]. On the contrary, lower count of 0.07 to 0.08 $\log_{10}$ cfu/g in frozen

turkey meat and 0.048 to 0.077 log_{10} cfu/g in chicken was reported by Nwachukwu and Nnamani (2013) [24] and Ibrahim *et al.* (2014) [17]. Comparatively higher SPC count of 6.3 to 6.6 log_{10} cfu/g and 6.37±0.06, 6.30±0.08, 6.30±0.06, 6.56±0.05 log_{10} cfu/g in ready to eat meat product and Beef shawarma, Beef burger, Hawawshi, Liver (kibda) sandwiches reported by Kumar *et al.* (2011) [20] and Sotohy *et al.* (2019) [32] respectively.

The mean value of coliform count of raw meat and value-added meat (chicken curry) was 314.66±145.33 to 425.00±340.08 MPN/g and 153.66±71.85 to 202.66±128.66 MPN/g respectively. The mean values of coliform count was observed in raw meat and value added meat samples (chicken curry) between all three zones was found to have non-significant variation (p>0.05) (Table 3 and 4). The mean value of coliform count of raw and value-added meat indicates marginally contamination in all three zones as per ICMSF (1978) [18]. These were supported by earlier observation of Martins *et al.* (1980) [26] and Shamsuddeen (2009) [30]. Who reported coliform counts in the range of 100 to 10,000 organisms per g and coliform count was >2400 for each sample.

Table 1: SPC count of raw meat samples (Chicken) from various zones of Durg district

Zone (Mean±S.E.) (log_{10} cfu/g)	Zone	Mean Difference	p-value
I (5.966±.4371)	II	-0.10000	0.862
	III	0.20000	0.729
II (6.066±.3179)	I	0.10000	0.862
	III	0.30000	0.606
III (5.766±.4055)	I	-0.20000	0.729
	II	-0.30000	0.606

(p<0.05-The mean difference is significant at 5% level)

Table 2: SPC count of value-added meat samples (Chicken curry) from various zones of Durg district

Zone (Mean±S.E.) (log_{10} cfu/g)	Zone	Mean Difference	p-value
I (3.000±.1154)	II	-0.06667	0.874
	III	-0.46667	0.290
II (3.066±.1855)	I	0.06667	0.874
	III	-0.40000	0.358
III (3.466±.4409)	I	0.46667	0.290
	II	0.40000	0.358

(p<0.05-The mean difference is significant at 5% level)

Table 3: Coliform count of raw meat samples (Chicken) from various zones of Durg district

Zone (Mean±S.E.) (MPN/g)	Zone	Mean Difference	P-value
I (425.00±340.085)	II	110.33333	0.798
	III	11.66667	0.978
II (314.66±145.333)	I	-110.33333	0.798
	III	-98.66667	0.819
III (413.33±344.544)	I	-11.66667	0.978
	II	98.66667	0.819

(p<0.05-The mean difference is significant at 5% level)

Table 4: Coliform count of value-added meat samples (Chicken curry) from various zones of Durg district

Zone (Mean±S.E.) (MPN/g)	Zone	Mean Difference	P-value
I (202.66±128.667)	II	49.00000	0.779
	III	24.33333	0.889
II (153.66±71.857)	I	-49.00000	0.779
	III	-24.66667	0.887
III (178.33±141.661)	I	-24.33333	0.889
	II	24.66667	0.887

(p<0.05-The mean difference is significant at 5% level)

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