STANDARDIZATION OF DIFFERENT SCALDING TECHNIQUES FOR PROCESSING POULTRY

By

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D E D I C A T E D

T O

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(JHARI SAHOO)

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CERTIFICATE I

This is to certify that this thesis entitled, "Standardization of Different Scalding Techniques for Processing Poultry" submitted for the degree of Master of Veterinary Science, in the subject of Animal Products Technology to the Haryana Agricultural University, is a bonafide research work carried out by Shri Jhari Sahoo under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

Major Advisor

CERTIFICATE II

This is to certify that the thesis entitled, "Standardization of Different Scalding Techniques for Processing Poultry" submitted by Shri Jhari Sahoo to the Haryana Agricultural University in partial fulfilment of the requirements for the degree of Master of Veterinary Science, in the subject of Animal Products Technology has been approved by the student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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* CHAPTER I*

INTRODUCTION

Poultry production in India, which remained as a non-commercial backyard venture till 1960, has grown into a fullfledged industry today. The remarkable rate of growth it has registered during the last one and half decades, cannot be matched with any other sector of animal production. Today, broiler production has crossed 17 millions from a figure of 4 millions in the year (1971) and it is projected to be 71.8 million by 2000 A.D. (Union Ministry of Agriculture, New Delhi, 1977). Between 1960 and 1976, poultry meat production has increased by 50% in the country while in the world the same has gone up by 106% between 1960 and 1977 as reported by Panda (1979). Mohapatra and Singh (1980) noted that the authorities have fixed the broiler production target at 35 millions by the end of sixth Five Year Plan and it is not difficult to achieve the above target if the same zeal for poultry production persists. They have also noted that inspite of this, the per capita consumption of poultry meat in India is only 137 gm as against 13-18 kg per head per year in developed countries. National Commission on Agriculture, Government of India, 1976 in their report quoted that Indian Council of Medical Research had recommended that every meat eating adult should be supplied with 30 gm of meat and fish per day. To achieve the same we have to go a long way. The National Commission on Agriculture (1976) has also reported that parallel with increase in broiler production, the demand for processed ready-to-cook broilers is also increasing. Two large poultry dressing plants one at Poona and the other at Chandigarh with an installed capacity of 8,000 and 4,800 birds per day respectively have been commissioned. Besides, many small poultry dressing plants capable of handling 2000 birds per day have also been set up. It is apparent from the report of Panda and Sri Hari (1971) that at present organized poultry farms supply 54%, countryside poultry collecting agencies or wholesalers 12% and other marketing agencies 7% of the total poultry available for sale. Out of this, 44.7% of the birds used for meat purpose are sold as live and 55.3% as dressed. Panda (1980) reported that with the acceleration of the present trend for production of further processed poultry products and the speedy rise in the sale of items as cut-up parts, pre-fabricated and pre-cooked forms, the proportion of the poultry that would be sold as frozen poultry is highly promising.

Among the processing factors that affect the quality of poultry meat during packaging, storage and marketing; scalding methods are of prime importance. The interest in scalding temperatures of poultry has arisen from the incompatibility under existing practices of three economic forces such as: (i) the demand by the consumer for a clean oven ready product free of pin feathers, (ii) the desire for a skin surface of uniform normal appearance that can be maintained throughout storage and marketing and, (iii) the need for less expensive methods of feather removal as reported by Pool et al. (1954).

Earlier people were not making any distinction between meat obtained from broiler, culled hens and cockrels. Now-a-days they have developed a quality consciousness and have started distinguishing broiler meat from other type of poultry meat. Hence, studies on the processing of poultry are very essential in order to promote marketing of poultry meat. However, no systematic studies have been carried out in India to know the exact scalding time-temperature schedule for different species and different age groups of poultry. Careless scalding causes bruised skin and more pin feathers, thus downgrading carcass quality for further processing. Proper scalding keeps the skin intact, gives better dressing yield and fetches more money to the producer.

Keeping these factors in view it is proposed to conduct studies with the following objectives:

(1) To assess the best scalding time-temperature schedule to be followed while processing different species of poultry commonly used for meat purposes.

(2) Pin point exact time-temperature schedule to be followed for different age group of poultry while processing.

(3) Bring out the advantages and disadvantages in the techniques in relation to keeping quality and acceptability of the finished products.

* CHAPTER II *

REVIEW OF LITERATURE

1. DIFFERENT SCALDING TECHNIQUES FOR POULTRY.

U.S. Department of Agriculture (1953) outlined various methods of scalding poultry. According to them poultry immersed in water heated to 160^{o}-180^{o}F for 30 to 60 sec. is taken as hard-scalded. The flesh of carcasses scalded in this manner expands and becomes slightly puffy under the skin so that the carcass appears plump. It is easy to remove the feathers from the carcasses scalded at this temperature than those scalded at lower temperatures but the flesh of such poultry is "doughy" and lifeless and the skin becomes discoloured soon after processing. Carcasses scalded in water of 138^{o}-140^{o}F for 30 to 75 sec. are generally considered as subscalded. Such carcasses have the outer layer of skin broken down but the flesh is not affected. The main advantage of sub-scalding is easy removal of feathers and a uniform skin colour. In this technique the skin surface is moist and sticky. It gets discoloured if left dry and uncovered. Semi-scalding, often called soft-or slack-scalding and is carried out at 123^{o}-130^{o}F for 90-120 sec. The chief advantage of the semi-scalding method is that it leaves the skin intact and therefore permits more diverse methods of chilling and packing. Its disadvantage is that it is harder to remove feathers and more hand pinning is required or additional pickers must be installed on the processing line. Recently, a new "semi-scald" system has been developed. It is now in use in a number of plants. Since the scalders are completely enclosed, blood and feathers are not splashed around the room and humidity, water spraying and noise and odour levels are greatly reduced. With this process, the carcasses are showered with hot water and then conveyed through humidity cabinets where they are sprayed with steam at 140°F.

Sundararasu (1979) stated that scalding is a process of immersing the killed carcass in hot water or melted wax for the purpose of removing feathers. He mentioned three ways of scalding such as hard-scalding, sub-scalding and semi-scalding with time temperature combination of 160°-180°F for 30-60 sec., 138°-140°F for 30-75 sec. and 123°-130°F for 90-120 sec. respectively. According to him scalding temperature is more important than scalding time. Klose et al. (1971) reported that treatment of turkeys or chickens with subatmospheric pressure steam at 138-140°F (59-60°C) for 1 or 2 minutes permitted complete feather removal with the cyclic pickers, resulting in a complete removal of outer layer of skin and typical sub-scalded appearance. Chicken fryers were rendered completely feather free by a combination of 2 to 3 minutes in 130°F (54°C) steam treatment followed by 1 minute holding in a cyclic picker. Veerkamp (1972) stated a new combined scalding/plucking process in which the carcasses were sprayed with warm water and mechanically plucked in a single operation. This new process was more rapid, gave birds of better carcass quality, reduced losses and gave significantly lower total bacterial and enterobacteriaceae counts than the normal method of 2-stage scalding and plucking. Levinger and Soroker (1974) stated that by using a chemical agent FSD (Poultry scalding chemical) the number of bone breaks and skin tears could be reduced by 50% in comparison to the control group. FSD considerably improved the efficiency of defeathering of wings, breast and back portions of the carcass. Reimer(1977) also mentioned the use of a scalding agent which contained water soluble polyalkoxylation products of a fatty acid and/or an aliphatic alcohol with ethylene oxide and/or propylene oxide. The agent also contained a small amount of antimicrobial agent, especially dodecyl-glycine hydrochloride. Use of scalding agent ensures gentle treatment of the skins while allowing effective removal of the feathers. Ramnani (1978) reported that scalding must take place in clean water. Birds are immersed about 2 min. in hot water at 126°-132°F to loosen feather follicles. Describing the methods used to process ducklings, Ziemba (1965) stated that the carcasses are scalded twice in rocker scalders, first at 140°F for two and a half minutes and then at 142°-145°F. Next they are picked on batch type pickers which holds 20 birds per lot. After drying the carcasses are dipped in wax at 195°F and then cooled in water at 55°F. Wax is removed by a wax stripping machine and the remainder by pinners. Mountney (1976) mentioned the scalding of geese. Geese are scalded at 150°-154°F in a home made rocking scalder. Flight and shoulder feathers are removed as soon as the carcass leaves the scalder. Centrifuging type pickers are usually employed to remove the remaining feathers. Any pin feathers left, are removed with an on the line picker. Then the carcasses are dipped in molten wax at 220°F for 3 to 5 sec., cooled, redipped at 160°F for 3 to 5 sec. and dipped in cold water to harden the wax and then stripped out. Then the carcasses are dipped in water at 180°F to tighten the skin to make it easier to remove rest of the pin feathers, if any. Gupta _et al_. (1978) found that a scalding temperature of 142°F for 2¼ min. is quite suitable for scalding ducks. Panda _et al_. (1979) reported regarding scalding of quails. They had mentioned that scalding should be done when all the reflexes were ceased. Quails are scalded at temperature of 138°F for 1.5 to 2 minutes. Scalding medium is kept agitated to ensure uniformity of temperature. Arumugam and Panda (1971) reported that scalding must not be done until all movements (reflexes) have ceased. The temperature of the scald water is usually about 140°F (60°C) and the poultry remain in it for about 2 minutes.

2. EFFECT OF SCALDING ON MEAT YIELD AND CARCASS GRADING.

Panda (1972) in a recent review has mentioned about various factors that influence the meat yield of dressed poultry. Coming into the yield of different tissues on post-slaughter, Mountney (1976), Jull (1951), Panda (1971, 1973) reported that the weight of blood lost ranged from 3.3 % to 4.8 % of live weight and weight of feather ranged from 4.5 % to 8.5 % of live weight. They also mentioned that small birds lose relatively more blood in proportion to body weight than large birds, but the reverse holds true for feathers. Large birds yield more feather than smaller ones. Comparing different methods of killing chickens, Davis and Coe (1954), Newell and Shaffner (1950) and Jain (1971) concluded that the best bled out value was obtained by severing both carotid arteries and jugular veins. Kotula et al. (1957) reported that blood loss (as percentage body weight) was more in case of male birds than female birds both in immobilized and non-immobilized condition during killing except the nonimmobilized condition and after 3 minutes bleeding time in which case female birds lost more blood. Panda (1973) stated that at least 3.5 % of the total volume of blood of the bird should be drained out to have better keeping quality of the dressed birds. Baker et al. (1950) indicated that preslaughter fasting accelerated bleeding. James et al. (1950) gave the evidence that hard scalding and plumping apparently coagulate the proteins in the cells of the skin which caused them to become more resistant to water absorption. Thomason(1978) and Wesley (1978) were of the opinion that during processing, soft scalded broilers not only picked up moisture but also retained more moisture than hard scalded ones. Also soft scalded birds weeped more moisture than hard scalded birds. Pool _et al_. (1954) concluded that the feather pulling force increased consistently with decrease in scalding temperature. Therefore scalding time is a much less critical factor than scalding temperature with respect to feather removal. Weight gains of New York dressed turkeys chilled in slush ice for 18 hrs. averaged more than 2% with significant difference within the scald temperature. Moisture losses by the birds during air chilling ranged from 1.0 to 2.7%. The greatest loss occurred in birds scalded at the highest temperature. Klose and Pool (1954) reported that moisture losses in frozen storage of box-packed New York dressed turkeys (toms) were directly correlated with the scalding temperature for both ice and air chilling conditions. Moisture losses in storage were greatest for the ice chilled groups than for the air chilled. Moisture losses from the eviscerated turkeys (hens) were negligible for all treatment groups. Arafa _et al_.(1978) reported that high scalding temperature and longer immersion time 134.5°F (57.2°C)/60 sec. and 140°F (60°C)/30 or 60 sec. significantly decreased cooking yield. Denes (1979) stated

Jull et al. (1943) observed in chicken that the ready-to-cook yield ranged from 67.3 to 70.2% of live weight. In another report Jull (1951) stated that the ready-to-cook yield ranged from 66% to 76%. He also reported that the ready-to-cook weight including the edible viscera varied from about 75 to 83% of the dressed weight. Ranganathan et al. (1967) found that the yield of edible parts in R.I.R., W.L. and Desi cockrels were 71.4%, 69.22% and 73.2% respectively. Gupta et al. (1978) reported that in White Pekin ducks the ready-to-cook yield obtained ranged between 68.36 % to 70.49 % which was almost similar to Snyder and Orr (1964). Hughes and Jones (1980) observed that in case of guinea fowl belonging to different sexes the eviscerated carcass yields including the neck and giblets was between 76.8% to 76.9%, respectively. Cooked yields as a percent of the eviscerated carcass including the neck and giblets, were 34.9% for total meat and 45.7% for total edible portions. Breast meat accounted for approximately 50% of the total cooked lean meat. Brant (1963) reported that carcasses absorb 2.0 % to 3.25 % moisture during washing. During chilling, the longer the immersion period, the greater the increase in moisture. Agitation of slush/ice water mixture has little effect on moisture absorption, but movement of the carcass has a pronounced effect. The temperature of the chilling mixture appears to have some effect. When polyphosphate at 6% level is added to the chilling solution, moisture absorption was reduced and moisture losses were less than with untreated groups during storage in crushed ice. Absorption of moisture is greatest in the skin, muscle, bone and fatty tissue in that order. Carcasses high in fat absorb less moisture than those containing less fat. Mountney (1966) reported that the gain in weight due to slush ice chilling was increased as chilling time increased. Woltersdorf observed that water uptake is around 11.3 % following spin chilling which may touch 27 % in certain cases,which should be limited to 10 % in order to get an acceptable product by following better techniques. U.S.D.A. has set up regulations which limit the weight increase permitted during washing and chilling for carcasses packed for consumer use or freezing based on the ready-to-cook weight in turkeys (9.072 kg or 20 lb or over, 4.536 kg to 9.072 kg or 10 to 20 lbs, under 4.536 kg or 10 lbs), in chickens (2.268 kg or 5 lbs and under), and in all other kinds and weight of poultry as 4.5 %, 6%, 8%, 8% and 6% respectively (Mountney,1976). He also stated that if the poultry is to be ice packed the maximum weight increase is 12%. Henry and Fromm (1958) reported that in most favourable conditions of moisture absorption a processor could only receive 3 to 12% per hundred pounds additional income by excessive water chilling. Winter and Clements (1957) have reported on a comparative study of the distribution of the cut-up parts for broilers, turkeys, ducks and geese. Breast meat made up the largest portion of large turkeys, ducks and geese and the legs and thighs the largest portion of broilers and small turkeys. Giblets amounted to 4% of the weight of the large turkeys and 10.7% of the weight of 11 lb geese. Walter et al. (1963) related the weights and sizes of broiler parts to carcass weights.

Switching on to the effect of scalding on carcass grading in different species of poultry, first of all the effect of bleeding should not be ignored as it affects grading as well as keeping quality. In this context, Benjamin et al. (1960) reported that poorly bled carcasses have poor keeping quality, undesirable flavour and an unappetizing appearance. Such carcasses have red areas over the neck, shoulders, wings and feather follicles which discolour on storage and visceral blood vessels are greatly engorged. Pearce and Lavers (1949) found out that feather pulling force was reduced as scalding temperature and time was increased. They also mentioned that damage to the skin by mechanical pickers increased as scalding temperature was increased. Gwin (1950, 1951 a, 1951 b, 1952) stressed the reduction of processing costs and the consumer appeal of the pin free sub scald product, but warned against the use of 140°F scald for air chilled New York dressed birds or inferentially, for any poultry product stored or marketed without adequate control of moisture loss. Reynolds et al. (1953) reported that rough handling causes an increase in excitement, temperature and nervous tension which results in improper bleeding, less effective scalding and so the feather removal is difficult, leading to undergrades. Knapp and Newell (1961) and Klose et al. (1961) were of the opinion that feather pulling force and scalding temperature were inversely proportional. They also stated that feather pulling force was more in males than female birds. Exercise for 90 sec. increased the feather pulling force, whereas tranquilizers or anaesthesia reduced it. Klose et al. (1962) reported the effectiveness in loosening feathers diminished in order: water, glycol, oil, Mountney (1976) pointed out the condemnation of over scalded birds are due to the reason that such carcasses were partially cooked, not properly cleaned, susceptible to bacterial growth, decomposition and deterioration. Fletcher and Thomason (1980) indicated scald water temperature decreased loose and broken skin scores, but increased oily skin scores. The greater picking stress resulted in increased moisture absorption, oily, loose and broken skin scores. Hood et al.(1955) reported that broken bones are the third most important factor in causing downgrading of eviscerated carcasses. Broken bones are caused by rough handling during assembly or processing. Mountney (1976) indicated disfigurement of skin and flesh maceration due to mishandling pickers which ultimately downgraded the carcasses.

Neb (1966) reported that semi-scalding (128^{o}F for 1-1½ minutes) was the commonly used method for processing broilers. He also indicated to use sub-scald temperature (138^{o}-140^{o}F for 30-75 sec.) only for the poultry that is tightly wrapped with a moisture resistant covering prior to freezing or tray packed poultry or those meant for immediate sale. Haleem et al. (1970) noted the scalding temperature to be (58^{o} to 60^{o}C) 136 to 140^{o}F for 60 to 120 sec. for processing broilers. Panda (1971) stated the scalding temperature of 136^{o}F (58^{o}C) for 1½ minutes for 10 week old or young birds and 140^{o}F (60^{o}C) for 1-2 minutes for culled birds. Kaufman et al. (1972) comparing steam scalded and tank scalded broilers, reported that steam temperature of 124^{o}F (51^{o}C) for 2 min. loosened the feathers sufficiently to give clean broilers comparable to birds tank scalded at 128^{o}F (53^{o}C) for 2 min. Both the methods had same shelf-life at 37^{o}F (3^{o}C) and about the same degree of tenderness. Ischhiramani (1977) reported the scald temperature for young chicken to be 138^{o}-140^{o}F and for culled hens to be 145^{o}-148^{o}F while the scald time to be 1¼ to 2 minutes depending on age and size. Khlebnikov et al. (1979) reported for processing broilers, the optimal conditions of processing time, hydrostatic pressure of water in the collecting vessel, and the processing temperature recommended for combined scalding and defeathering method of poultry are important.

Sathe (1970) reported that semi-scalding was superior as far as the finish of broiler carcasses are concerned. He also suggested that improper scalding could take the skin off in patches and adversely affect meat yield. At high temperature part of the epidermis is lost resulting in drying of the skin and loss of finish. Scholtyssek et al. (1970) reported that for processing broilers, a scalding temperature of 122-125^{o}F (50-52^{o}C) is good as it resulted in lower weight losses, lower pH values and a better tenderness than a scalding temperature of 135-137^{o}F (57^{o}-58^{o}C). Ristic and Schon (1977) while studying the changes in the muscle pH of broilers, reported that scalding temperature 118-122^{o}F or 132.8-137^{o}F (48-50^{o}C or 56-58^{o}C) had little effect on muscle pH. Jaap et al. (1950) summarized the meat yield records of 1325 chickens at 12 week age and reported that the maximum dressed and eviscerated yields was 91.3 % and 72.2 % respectively. Mathur and Ahmed (1968) reported that the dressing yield of Arbor Acres broilers was between 89.91% to 91.24% while the eviscerated weights ranged 71.08% to 71.13%. They also mentioned the total loss from live weight to ready-to-cook weight was from 28.86% to 28.92%. The eviscerated loss was higher in cockrels than in pullets. The processing losses were higher for lighter birds. Dressed yield ranged from 85 to 90% of the live weight and evisceration yields varied from 67 to 75% in case of broilers according to the published reports of Jull and Maw (1923), Vernon (1923), Lowe (1941) and Jull *et al*. (1943). Mentioning the meat yield of different broiler breeds, Hathaway (1953) reported that Dark cornish yield the highest percentage of total edible meat based on live and on eviscerated weights. They also pointed out that breast width was the best single measurement for predicting percentage breast meat and total edible meat yields in 12 week old chicken. Mountney (1976) reported that shrinkage, in general, is greater in young birds and light weight ones than in older or heavier birds. Haleem *et al*. (1971) and Haleem and Madhwaraj (1972) reported the percentage yield of dressed eviscerated weight with neck and giblet on the live weight basis (both sexes included) at ages of 6th, 8th and 10th week. It was found, in general, neck percent and giblet percent decreased and dressed, eviscerated percent yield increased, as the age was increased from 6 week to 10 week. Haleem and Madhawaraj (1972) reported that 8th or 10th week was the best slaughter age for broilers, whereas for roasting and canning purpose the 12th week appeared to be more suitable. Cut-up yields were higher for males than the females for the same age. Arora *et al*.(1972) studied about the relationship of dressing yield to some of the physical carcass characteristics in chicks and gave prediction equations between various carcass characteristics and dressing yield. Bolder (1976) reported that water uptake during washing and chilling tended to vary inversely with water uptake during scalding/plucking/evisceration. Thomason (1979) reported that there was more moisture uptake, weeping and water retention in case of semi-scald broilers as compared to hard-scald broilers. In the 19 week old female large white turkeys, Salmon (1980) reported that dry plucking (by hands) increased weight loss due to plucking and eviscerating and reduced chilled carcass yield as compared to wet plucking (scalded for 1 min. at 145°F or 63°C). Dry evisceration increased carcass water uptake during chilling than wet evisceration. Water uptake during chilling appeared to be increased by longer eviscerating time. Singh et al. (1980) studied about slaughter characteristics of Japanese quail. They reported that younger birds tended to have more shrinkage percentage due to starvation. Dressing percent increased significantly upto 6 and 7 weeks in females and males, respectively. Evisceration percent yield was nearly the same in both the sexes upto 6 weeks but it was significantly higher in males than females, during later period of growth. Females of same age had higher percent of giblets than males. Total offals percent increased significantly in females than males at 7 and 8 weeks. Breast constituted the highest cut followed by back, thighs, wings, drumsticks and neck. Parnell et al. (1950) reported that moisture loss for unwrapped fryers in frozen storage for 6 months was twice as great for 145°F scalded birds as for

126^{o}F scalded birds. Margolf et al. (1956) reported that weight losses were greatest for carcasses wrapped with cellophane, less for those wrapped with pliofilm and least for those wrapped with polyethylene in case of both full-scald and semi-scald New Hampshire pullets.

Experiments conducted on scalding conditions and its effect on xanthophyll composition and colour of broiler skin by Heath (1972, 1973) and Heath and Thomas (1973, 1974) have shown that there was a significant decrease in both skin colour and xanthophyll content as the temperature as well as scalding time of the scald water increased. There was a rapid loss when the temperature was increased above 130^{o}F (54^{o}C). The largest decrease in the xanthophyll concentration in skin occurred during scalding, while the largest decrease in the feather tract occurred during picking. Concerning altering of the pH of scald water by scald additives, Heath and Wabeck (1975) stated that the pH of the scald water which indicated the optimal level of additive for feather removal (pH 8.5) also retained the most yellow colour of the skin. He also suggested to constantly maintain the optimum concentration of additive. Parnell et al. (1950) reported that all the fryers scalded at 126^{o}F were classed as Grade A, while those scalded at 145^{o}F were all Grade C, because of numerous skin abrasions. Panda et al. (1967) reported that 13 to 15 week age group of poultry showed more breast blister and breast bruising percentage than 10 to 12 week age group, when they were reared and processed under similar conditions, indicating difference in skin sensitivity based on age to the aforesaid defect. Baker (1954) reported that the semi-scalded carcasses which were air-cooled were the lightest in colour, while those sub-scalded and water-cooled were the darkest. He was also of the opinion that there was a gradual darkening of the flesh as the rate of freezing became slower, which was also confirmed by Baker (1955), Loy (1956), Klose and Pool (1956) and Esselen et al. (1955).

3. MICROBIOLOGICAL ASPECTS OF DRESSED POULTRY IN RELATION TO THEIR KEEPING QUALITY.

The source of contamination of dressed poultry are many. The bird itself serves as a potential source of contamination. Diseased and carrier birds serve as the source of contamination for other healthy birds during further handling and dressing. Ayres et al. (1950), Drewinak et al. (1954) and Mead and Impey (1970) suggested that bacteria found on the skin of live birds were derived largely from feet, feathers, and skin. These organisms present on the skin of live birds may gain entry into the finished product. Walker and Ayres (1956, 1959) estimated the total count of the skin of live chicken to be 1500 organisms per sq.cm. and that approximately 4700 organisms per sq. cm. could be recovered from the skin of turkeys. The environment of processing plant, cutting tools used for dressing poultry,plant personnel, water, packaging material and ice used for chilling have been observed to act as important sources of microbial contamination (Walker and Ayres, 1959; Nagel et al.,1960; Ayres, 1959; Ayres, 1966; May, 1962). In addition, the role of dressing and eviscerating lines of a processing plant in disseminating microorganisms have been amply stressed by many workers including Drewinak et al. (1954), Gunderson et al. (1954), Walker and Ayres (1956), Barness (1960), May (1961), Kotula et al. (1967) and Surkiewicz et al. (1969). Kraft(1971) reported that the type of picking equipment is responsible to a great extent in contaminating the finished product. Faecal contamination of the carcasses during careless evisceration has been stressed by Notermans et al. (1980). It is interesting to note that even during spray washing, only part of the faecal contamination is cleaned because of the irreversible attachment of faecal bacteria to the skin of carcasses (Veerkamp et al., 1972). It has been shown (Notermans and Kampelmacher, 1974; Blankenschip, 1977) that bacteria and bacterial spores remain attached to chicken skin. The mechanism of attachment consists of primary and secondary attachment processes (Notermans et al., 1979; Firstenberg Eden et al., 1979). During the primary stage bacterial attachment is probably due to physical forces and the number of bacteria becoming attached is proportional to the number in the water film over the surface. The secondary stage is characterized by an increased strength of attachment which is a time dependent process.

Several reports have been published about the association of various types of microorganisms on dressed chicken both at the processer as well as retailers level (Panda,1975). He also has listed the details of such isolations made by different workers. It is clear that organisms belonging to 24 different genera can be commonly seen on dressed poultry. Some of these organisms are pathogenic and rest are not. Among the pathogenic ones the importance of Salmonella and Staphylococcus from public health point of view is agreed by one and all. The incidence of salmonella responsible for illness of human beings has been reported by Gunderson _et al_. (1954), Galton _et al_. (1955), Bobset _et al_. (1958), Morris and Ayres (1960), Wilson _et al_. (1961), Wilder and MacCready (1966) and Woodburn (1964), in poultry processing plants whereas the workers such as Wilson _et al_. (1961), Woodburn (1964), May (1969), Panda and Basu (1973) and Panda (1973) reported the incidence of salmonella in poultry and poultry products sold in retailing stores in different parts of the globe. Like salmonella, Staphylococcal organisms are also important in dressed poultry. According to a report published by Kraft (1971), one fifth of the staphylococcal out-breaks were of poultry origin. Besides this, Radhakrishnan and Panda (1977) also indicated the presence of certain E.coli in dressed poultry belonging to serogroups known for causing human health problems.

Microbial number has a definite role to play in predicting the shelf-life of a processed chicken. Lot of variations in total microbial load in dressed chicken have been reported. Gunderson et al. (1954) have shown that the total microbial count of freshly killed warm eviscerated chicken is about 4800 per sq. cm. which might go upto 60,000 per sq. cm. in ice chilled chicken. Walker and Ayres (1956) reported that live chicken had 1500 organisms per sq. cm. of skin, but on eviscerated carcasses this went up to 35,000 per sq. cm. They detected a 20-fold increase in the microbial number during processing. Walker and Ayres (1959) detected 750 to 41000 organisms per sq. cm. of skin in live turkey. McCarthy et al. (1962) reported that bruised tissue had a greater permeability to penetration of dye and microorganisms than normal tissue. Panda (1967) observed that staphylococcal organism was associated with breast blisters and bruises. Panda (1971) indicated that the microbial number of warm eviscerated chicken sold in the retailing centres of the country was found to range between 2.5×10^5 to 5.4×10^6 per sq. cm. May (1969) evaluated the total count of chicken purchased from retailing units to lie in the range of 10^2 to 16.8×10^7 per sq. cm. It has been seen that with the rise in the microbial number the shelf-life of the dressed bird gets decreased. May et al. (1962) reported that spoilage changes could be noticed in the carcasses when the total count approached 10^9 per gm of tissue. Lockhead and Landerkin (1935) and Ayres et al. (1950) reported that spoilage of poultry held at refrigerator temperature was due to growth of slime forming bacteria on the exposed meat surface. They also stated that the total number of microorganisms growing on the surface reached approximately 10^8 before off-odour and sliming were evident. Elliot and Michener (1961) reported that off-odours appeared from poultry carcass when log of the number of bacteria reached from 6.5 to 8.0 per sq. cm. and slime formation occurred when the number of organisms reached a log concentration of 7.5 to 9.0 sq. cm. Panda (1970), Essary et al. (1958) and Ayres et al. (1950) have shown that development of off-odour in dressed birds become prominent when the microbial counts reached 10^7 or 10^8 per sq. cm.

During processing of fresh poultry the bacterial population in the finished product is expected to be as low as possible in order to obtain a good market poultry. To achieve it, careful attention should be given in every step of the processing, because it is very clear that dressing and evisceration line are the main avenue for bacterial dissemination. Due to different methods of killing and scalding operations air sac contamination occurs in poultry which was studied using streptococcus faecalis as a tracer organism (Thompson and Kotula, 1959). The two common methods of killing are outside cut (trachea intact) and Kosher cut (trachea severed). When the former method is employed,the bird may gasp water during scalding and thereby draw large number of organisms present in the scalding tank to the air sac, contaminating the finished product. But, the latter method minimizes this problem. Perfect bleeding at the end of killing has also been observed to influence the bacteriological condition of the dressed chicken. Panda (1973) showed that the keeping quality of the dressed birds was better when there was perfect bleeding and the amount of blood recovered per bird was more than 3.5 percent. Scalding is another step in processing where microbial contamination can occur easily. Tarver and May (1963 b) reported that the microbial load increased with each scalded bird, though in the beginning the microbial count of the scalding tank was negligible. Gunderson et al. (1954) reported total counts as high as 292 million per ml of scald water. Walker and Ayres (1956, 1959) found the microbial counts ranging from 5,900 to 17,000 organisms/ml in the scald water of chicken dressing plants and a mean count of 2,800 organisms/ml of scald water of turkey processing plants. Nagel <u>et</u> <u>al</u>.(1958) estimated 400 to 2,500 bacteria/ml of scald water of chicken processing plants. The variation in the said figures can be explained as due to (i) variation in the scalding tank temperature, (ii) initial low counts in the live bird of certain batches, (iii) dilution effect of the fresh addition of scald water. Sahu (1974) showed that use of a sanitizing agent in the scalding may be beneficial to minimizing the microbial load of the scalding tank. Many a literatures are available regarding scalding methods and cross-contamination. Comparing two methods of scalding, Patrick <u>et</u> <u>al</u>. (1971, 1972) reported that total plate counts from steam scalded birds were significantly lower than the counts of water scalded birds immediately after scalding and picking. No difference in the two methods would be found after chilling. Coliform counts from birds after steam scalding were significantly lower than the counts of water scalded birds. Bartles and Wohner (1972) reported that scalding carcasses with air at 176^{o}F (80^{o}C) and 97-98% relative humidity with an air speed 10 M/S for 100 S is preferred to hot water scalding from poultry slaughter hygiene angle. Lillard (1973) concluded that scald water could contaminate respiration system, digestive system as well as circulating system, thereby contaminating edible meat. He stated this after isolating indicator organism from thigh meat. Lillard <u>et al</u>. (1973) also concluded that counts from lungs of broilers scalded by subatmospheric steam were significantly lower than counts from lungs of water scalded broilers. Lahellec (1976) showed that significant cross contamination with salmonella and staphylococci during plucking by studying the effect of spray scalding and steam scalding. Mulder <u>et al</u>. (1978) pointed out that broilers which were contaminated externally (dust and feather) before scalding resulted in more numerous contaminated carcasses after whole slaughtering procedure than those contaminated internally (intestinal). Hamm (1972) suggested improved techniques and equipments for scalding operation to reduce pollution. Pelletan (1972) stated that the highest contamination occurred during scalding and there was a rapid increase in the bacterial count in the scald water and so he recommended continuous recycling and sterilization of the warm water. From poultry hygiene angle, Grossklaus (1972) recommended sub-scalding of chickens at 136^{o}F (58^{o}C) for 40 sec. and hard scalding ducks and geese at 176^{o}F (80^{o}C) for 5-10 sec. There are also extensive studies in relation to heat sensitivity of micro-organisms due to scalding operations. Essary <u>et al</u>. (1958) found no difference between types of organisms on the carcasses scalded at 128^{o}F and 138^{o}F. Clark (1968) reported that Pseudomonas grew best on skin scalded at 138^{o}F (59^{o}C) and Achromobacter grew best on unscalded skin. Notermans and

Kampelmacher (1975) showed that mesophilic bacteria (E.coli, Klebsiella spp., S.oranienburg) were more heat resistant when attached to broiler skin than when not attached. The rate of destruction of psychrophiles (Pseudomonas spp.) was logaricthmic in both attached and non-attached state. Bacteria surviving scalding were not generally removed during defeathering or spin chilling. Notermans et al. (1977) reported that with scalding broiler chickens at more than 140°F (60°C) Enterobacteriaceae and E.coli counts were greatly reduced and psychrophiles were undetectable after scalding at all temperatures studied (53° - 61°C). Mulder and Dorresteijn (1977) reported that microbial counts were reduced by 2.5 to 3.0 log with scalding water at 140°F (60°C). All water samples with temperatures of 125-140°F (52° - 60.5°C) showed positive for Clostridium perfringens but water sample was positive for salmonella only at temperature less than 132.8°F (56°C). The effect of scalding on shelf-life of the finished product has also been studied by some workers. It is agreed by one and all that skin serves as bacterial barrier so long it is kept intact. Studies on skin as bacterial barrier by Mundt et al. (1954) concluded that processing normal healthy birds under sanitary conditions was not conducive to carrying bacteria into or through the skin. May (1962) reported that the principal sites of bacterial growth on a chicken carcass appears to be the skin surface and the visceral cavity. Arafa _et al_. (1978) stated that the number of the microorganisms on the carcass surfaces decreased as scalding temperature increased provided the skin remained intact. Ziegler and Stadelman (1955) indicated that approximately one day more shelf-life is obtained by slack-or semi-scalding (128°F) than with sub-scalding (at 140°F) and it was statistically highly significant. Balsano (1978) reported that use of 0.15% san-pel in scalding water at 123.8°F (51°C) reduced greatly the bacterial counts after plucking and the storage time of poultry was increased by 4-5 days. Kidneys and livers of healthy carcasses are some times a source of bacterial contamination as proved by Essary and Howes (1960). So he suggested to store liver separately from meat to increase shelf-life. Walker and Ayres (1956, 1959) reported that the number of microorganisms generally increased during evisceration. The skin of a live chicken was found to have a count of about 1500 organisms per sq. cm. and that of a turkey approximately 4700 per sq. cm. but for the final product, the median count on the skin surface of the chickens was 35000/cm^2 and 44,000/cm^2 for the skin surface of turkeys. That was nearly 10-fold increase for turkeys and more than a 20-fold increase for chickens. May (1961) found counts to be relatively low after pick and wash, then the count increased as the carcass progressed through various stations to the final wash. Keel and Parmelee (1968) and Fromm (1959) stated that the bacterial load of eviscerated carcasses could be effectively reduced by using a greater volume of wash water along with scrubbing action of the rubber fingers in the washer. Removal of kidneys during evisceration has been shown to extend the shelf-life for 1-2 days or more in comparison to control ones by Essary and Howes(1960). Galton <u>et al</u>. (1955) mentioned that isolation of contaminants like Salmonella from tables and trays containing edible viscera was comparatively high when wash water availability on the table was limited and was considerably low when the reverse was true. Salzer <u>et al</u>. (1967) recovered 17% coagulase positive Staphylococci from liver before washing which came down to 1% at the end of it. Discussing the effect of chilling on microbial load Kotula <u>et al</u>. (1967) stated that use of an oscillating vat type continuous chiller or counter flow tumbler type chiller keep the bacterial count at a minimum. On the other hand when a standard chilling tank without agitation was used for the purpose of chilling chicken the counts went up within a period of 6 hours. Casle <u>et al</u>.(1965) also believed agitated ice water chilling is beneficial in reducing the bacterial counts on the skin surface of dressed chicken. Pietzsch and Levetzow (1974) observed that spin chilling runs a risk of cross contaminating the product in comparison to spray chilling. Kraft (1971) pointed out that greatest incidence of Salmonella was recorded following feather removal which decreased to a great extent later at the end of evisceration and final washing in a turkey processing plant. Overnight chilling in tanks, however, increased the incidence of Salmonella and Staphylococci to a great extent. Dawson et al. (1956) found that addition of chlorine to the chilling water at levels of 140 ppm increased the shelf-life of the product. Similar reports have also been published by Ranken et al. (1965) and Patterson (1958) by using chlorine in slush ice chilling tanks at levels of 200 to 400 ppm. Panda (1970) and Eklund et al. (1961) have shown application of chlortetracycline in ice chilling water assists in increasing the shelf-life of birds. Ayres et al. (1956) also tested various types of antibiotics including chlortetracycline, oxytetracycline, tetracycline, streptomycin, neomycin, aerosporin, rimocidin, myprozine, mycostatin and ascosin to prolong storage life of birds while holding at 41°F (5°C) following dressing and observed chlortetracycline to be the best. Very little information available about the level of bacterial contamination during cutting and packing of the birds. May (1962) reported that the bacterial load increases by 6 folds in the plants and 8 folds in the stores mainly due to increased contact with the work surface. Much work has been done to retard the growth of microorganisms and so to increase the shelf-life by manipulating temperature, pH and by using preservative and carbondioxide. Dawson and Stadelman (1960) found that when carcasses are stored close to 32°F it takes approximately 18 days for spoilage to occur, when stored at 37°F it takes 11 days and at 68°F only 2 days.

4. ORGANOLEPTIC EVALUATION OF POULTRY.

Some fundamental research has been underway to isolate and identify the chemical compounds which are responsible for the flavour of poultry meat. Bouthilet (1949) isolated a flavour constituent which appeared to be a weak acid produced in the flesh during cooking. Bouthilet(1950) reported that volatile compounds responsible for chicken flavour could be stripped from a broth and concentrated by means of a fractionating column and then recombined to produce a broth undistinguishable from natural chicken broth. Bouthilet (1951 a) demonstrated the presence of ammonia in the volatile fraction and reported that sulphur compounds are also responsible for part of the flavour. In later work (1951 b) he reported that the "Meaty flavour" of chicken is found in the meat fibers and has properties similar to glutathione. Pippen _et al_. (1954) found that although fat contributes to the aroma of chicken broth, it does not have much effect on flavour. Chicken meat was found to be a better source of flavour than bones, skin or mixture of the three. Fry et al. (1958) reported that taste panels could pick up differences in chicken broths between 6, 10 and 14 week old birds. They also reported that the flavour of baked chicken was influenced chiefly by age(Leong et al. (1958). Lineweaver (1961) concluded that age, sex, variety and production conditions do not have too much influence on flavour under ordinary conditions. Studying on the breed difference for flavour, Hanson et al. (1960) concluded that the modern bird has as much chicken flavour as the old style bird. Wasserman (1972 a) presented an excellent review on flavour components in the aroma of meat and poultry with particular emphasis on thermally produced flavour components. He reported that variation in flavour occur among species, strains, and even within the individuals. Hydrogen ion concentration and chemical changes which are influenced by starvation, a low plane of nutrition, emotional state, and other factors also influence flavour and aroma as well as the characteristics of the fat fed to animals. Conventionally raised chicken have a more characteristic "chicken" flavour than those produced in a germ-free environment. Other factors that influence flavour are aging and its influence on carbohydrate breakdown, protein denaturation and fat breakdown. Cooking method like stewing compared to roasting also has a profound effect on aroma and flavour. The second most important eating quality factor of poultry meat to be considered is tenderness. For tenderness of poultry meat crossbreds are preferred to indigenous pure bread (Kumar et al., 1971). Even there is difference in tenderness between crosses in the breed (Larmond et al., 1970). The increase in tenderness due to the effect of oestradiol-17 B monopalmitate (caponization) in case of chicken broilers and roasters has been shown by York and Mitchell (1969) and Megally et al. (1969). The meat from females in case of large turkeys was found to be more tender than that from male ones (Aert , 1977). The effect of age on tenderness is well known to one and all. As age advances, tenderness decreases and this has been reported by Larmond and Moran (1969), Pelczynska (1974) Wagen and Skala (1968), Nakamura et al. (1975), Jeremiah et al. (1971) and Choo and Thiam (1973). All these workers are of the opinion that the possible reason of decreasing tenderness is due to increase in insoluble collagen in meat tissue as age advances. Meller et al. (1958) found out that carcasses with high concentration of glycogen had lower shear values than muscles with low glycogen concentration. Antemortem environmental stress factors such as heat stress, cold stress, transport time and flock density interfere with postmortem glycolysis and so affect tenderness of poultry (Lee et al., 1976, Ehinger, 1977 and Dean et al., 1972).

Besides live poultry, considerations should be made about different factors affecting eating quality of poultry during processing and storage. While processing fresh poultry, emphasis is given here about the effect of scalding on organoleptic properties of poultry. Comparative studies were made between slack versus subscalding for broilers by Lineweaver and Klose (1952), Baker (1955 a) and Graf and Stewart (1953). All of them were of the opinion that sub-scald carcasses had a glossy appearance and were slightly sticky, whereas semi-scald carcasses had normal appearance. A panel of judges preferred slack scalded (semi-scalded) over sub-scalded birds from the stand point of appearance of thawed and frozen birds and texture of cooked birds. However, they could not detect any difference in flavour. The altered skin surface in sub-scalded broilers were more susceptible to dehydration and darkening during processing, storage and marketing (Klose and Pool, 1954 and Pool _et al._, 1954). Doing experiments on New Hampshire broiler, Baker (1954) reported that semi-scalded carcasses which were air-cooled were the lightest in colour, while those sub-scalded and water-cooled were the darkest. Rate of freezing played a major role as far as discolouration of these carcasses are concerned. There was a gradual darkening of the flesh as the rate of freezing became slower (Baker, 1954, 1955;

Loy, 1956; Klose and Pool, 1956 and Esselen _et_ _al_.,1955). Pool _et_ _al_. (1954) reported that appearance of turkeys scalded at 132°F was inferior to that of 140°F scalded birds because of the splotchiness of the 132°F lot resulting from only partial removal of skin. Klose and Pool (1954) reported that increase in scalding temperature produced marked increase in toughness and wrinkling of roasted skin. The results suggested that turkey scalded at higher (140°F) temperature represent an acceptable product for frozen storage if proper moisture control is maintained throughout, from slaughtering to consumption. Klose _et_ _al_. (1956) observed that high scalding temperature, long scalding temperature and excessive beating by picking machines have an adverse effect on tenderization. Shrimpton (1960) reported that increasing the scalding temperature delayed the breakdown of glycogen with a similar delay in formation of lactic acid. This might be the cause of toughness of meat. Dodge and Stadelman (1960) reported that under normal processing conditions struggling had little effect on tenderization. Dodge and Stadelman (1959) also observed that the time of aging, the temperature of ageing, and the media in which the carcasses were aged appear to influence tenderness. Klose (1960) reported that scalding of poultry at 140°F resulted in the loss of the pigmented epidermal layer, but it did

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Arumugam and Panda (1971) reported that at sub-scalding temperature 140°F (60°C) the flesh became tough as compared to scalding temperature of 131-135°F (55° to 57°C). Same conclusion was drawn by Singh and Mohapatra (1979) but they pointed out that the effect of scalding time on tenderness is greater than that of scalding temperature. They also suggested that excessive beating by mechanical picker increased the toughness of cooked meat. Pandey and Singh (1979) reported that scalding the birds above 140°F (60°C) for 2 min. gave it a "cooky flavour". Johnson (1971) reported that machine plucking produced a detrimental effect on cooking loss and juiceness. High scald temperature also had a negative influence on juiceness. The effect of scald temperature on duck and goose meat was studied by Gey and Pingel (1977). They compared two scalding temperatures such as 135°F (57°C) and 144°F (62°C) using not affect appreciable reduction in the nutritive value. Klose *et al*. 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The results indicated that high scalding temperature and longer immersion time significantly decreased cooking yield, and produced tough meat with a low flavour score. Scalding at 135°F (57.2°C)/ 30 sec. is recommended for Bobwhite quail. The effects of scalding on tenderness of chicken meat after ageing was reported by Shannon _et_ _al_. (1957). They found that the harmful effect was due to time temperature abuse. Klose and Pool (1953) reported that there was no important development of rancidity in the skin fat of New York dressed turkey after 6 month at -5°F or in the skin fat of packaged eviscerated turkeys after 12 month at -5°F for any of scalding temperature (120°F to 140°F) studied. Klose and Pool (1954) found that turkey carcasses scalded at 140°F (60°C) darkens the carcasses when they are frozen as freezing increases the skin's transparency.

* CHAPTER III *

MATERIALS AND METHODS

1. Standardization of scalding techniques in different species of poultry

(a) Chicken : White Leghorn female birds of 44 weeks age reared under similar conditions of feeding and management were collected in batches of ten for each experimental treatment (time-temperature combination) daily from the poultry farm of the College. All total 90 birds were obtained for 9 treatments. The experiments were conducted during the month of March, 1980.

All the 10 birds in every batch were transferred in the evening hour from the poultry pen using wire-bottomed holding crates to the holding section where they were fasted for 16 hrs. Preslaughter fasting was done by depriving feed and supplying sufficient clean water. In the morning hours of next day, slaughtering was done. For this, initial live weight of each bird was recorded before slaughter. Each bird was identified with wing band number. Then the birds were hanged in bleeding cones. Slaughtering was done without stunning, using a sharp knife. The jugular vein and carotid artery were cut below the ear lobe of both the sides as per "Modified Kosher" method (Mountney, 1976). Bleeding was done for 2-3 minutes. After all the reflex movements ceased, they were transferred from the slaughter house to the departmental laboratory for further processing.

A scalding tank with thermostatic control was used for the scalding operation. According to the procedure outlined by U.S.D.A. (1953), hard-scalding, sub-scalding and semi-scalding were carried out. The corresponding temperatures maintained were 77°, 60° and 53°C. Scalding time was fixed for 60, 90 and 120 sec. for each scalding temperature. So, all total there were 9 time temperature combinations. The details of each treatment are as stated below:

Batch I	:	77°C/60 sec.
Batch II	:	77°C/90 sec.
Batch III	:	77°C/120 sec.
Batch IV	:	60°C/60 sec.
Batch V	:	60°C/90 sec.
Batch VI	:	60°C/120 sec.
Batch VII	:	53°C/60 sec.
Batch VIII	:	53°C/90 sec.
Batch IX	:	53°C/120 sec.

Feather picking was done manually. Then the birds were washed using running tap water. Shanks and oil glands were removed. Opening of body cavity was made with knife using slicing motion. Method used for removal of viscera was outlined by Childs and Walters (1962). Giblets were processed separately. Lung was removed by hand rake. Then wind pipe and crop was removed and neck was separated from the back close to the body with knife. Afterwards, giblets were wrapped and stuffed inside the body cavity. Then they were given a final washing and grading of ready-to-cook carcasses was done according to the specifications laid down by U.S.D.A. (1961) as per Appendix - I. The carcasses were, then, air chilled at $4^{o} \pm 1^{o}C$ in refrigerator for 24 hours.

To record the meat yield and dressing percentage, a very sensitive balance (with 0.25 g error) was used. Different weights were recorded as per Appendix - II.

(b) Ducks : Five Mini Kos female birds of one year age were collected for each experimental treatment daily from the Duck Farm of the College. All total 45 birds were obtained for 9 treatments. The experiment was conducted during the month of May, 1980. All the birds used for the study were under similar feeding and managemental conditions.

Birds of each batch were transferred in the evening hour from the poultry pen using wire-bottomed holding crates to the holding section of the slaughter house where they were given preslaughter fasting for 16 hours. No feed was supplied except sufficient amount of clean water. In the morning hours of next day the ducks were slaughtered as per the procedure described by Gupta *et al*. (1978). Grading was done according to the specifications laid down by

Panda (1977). Necessary data about meat yield and grading defects were collected as per the Appendix I & II and were interpreted.

2. Standardization of different scalding techniques for different age groups of poultry

For this, the effect of scalding techniques on adult age group (44 weeks old) and broiler age group (9-10 week old) of chicken was studied. The materials and methods for adult age group of chicken have already been described. Regarding broiler age group of chicken, ten Abor Acres 9-10 week old male birds, were obtained daily, for each experimental treatment. Thus, total 90 birds were collected for 9 treatments. Experiments were conducted in the month of April, 1980. All the birds used for the study were under similar schedule of feeding and management. Information on meat yield, dressing percentage and grading defects were collected and analysed as to assess the best time temperature combination which can be recommended for scalding adult chicken and broilers.

3. Effect of scalding on the bacteriological condition of dressed poultry

Bacteriological condition was determined by carrying out total plate count, Coliform count, Streptococcus faecalis count and total mould count from the skin surface of carcasses. The initial microbial evaluation was made just before deep freezing (i.e. after air chilling of 24 hours in refrigerator) and the final microbial evaluation was made from the skin surface of the carcasses after 3 months of storage in deep freeze at -10°C temperature.

For initial microbial evaluation, the ready-to-cook carcasses were obtained after air chilling of 24 hours. Three carcasses were taken, out of 10 birds lot in each experiment except duck carcasses, in which three carcasses were taken, out of five carcasses. Sampling was done by swab technique as described by Mallmann et al. (1958). Peptone water containing 1% peptone and .5% sodium chloride was used for ten-fold serial dilutions of 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} as recommended by Murray (1956) and Straka and Strokes(1957).

(i) Total Plate Count : Total plate count was done by using Tryptone-Glucose Yeast Extract Agar as per the procedures prescribed by the American Public Health Association (APHA, 1960). The composition of the media used is as follows:

Tryptone-Glucose-Yeast Extract Agar :

Tryptone	5.0 gm
Glucose	1.0 gm
Yeast extract	2.5 gm
Agar	15.0 gm

Distilled water	1000 cc.

pH 7.0 ± 0.1 was adjusted by using BDH indicator strip.

Sterilized at 121°C or 15 lbs steam pressure for 15 minutes.

Incubation at 35° ± 1°C.

One ml of homogenous suspension from each dilution was transferred to different sterile petridishes with the help of sterile pipettes. About 20 ml of melted tryptone glucose yeast extract agar (at 43° to 45°C) was poured in each petridish which was then rotated in such a manner to facilitate uniform distribution of the materials in the medium. The medium was allowed to solidify. Duplicate plates were prepared for each dilution separately and were incubated at 37°C for 48 hours. The plates containing 30 to 300 colonies of bacteria were selected for enumeration. The number of bacteria per sq. cm. of skin surface of the poultry carcass was calculated by multiplying the number of colonies with the respective dilution factor.

(ii) Coliform count : Coliform count was done using the medium Eosine Methylene Blue Agar - Levine (APHA, 1960). The composition of EMBA-Levine used is as follows:

Peptone	10 gm
Lactose	10 gm

Dipotassium phosphate	2 gm
Eosine Y	0.4 gm
Methylene Blue	0.065 gm
Agar	15 gm
Distilled water	1000 ml

pH (final) 7.1 ± 0.1 was adjusted by using BDH indicator strips.

Autoclaved at 121°C (15 lbs pressure) for 15 minutes.

Inoculated plates were incubated at 37°C for 24 to 48 hours. The enumeration was done by seeing the colony character and staining properties.

(iii) <u>Faecal Streptococcal count</u> : Slanetz and Bartley's Enterococcus Agar was used for the enumeration of Streptococcus faecalis. The composition of the medium used is as follows :

Peptone	20 gm
Yeast extract	5 gm
Glucose	2 gm
Disodium hydrogen phosphate	4 gm
Sodium Azide	0.4 gm
Agar	10 gm
Distilled water	1000 ml

pH 7.2 adjusted by using BDH indicator strip .

To the melted Slanetz's Agar basic medium cooled down to 45°C, 1 c.c. 1% 2, 3, 5 Triphenyl tetrazolium chloride was added per 200 ml of medium. After inoculation, the plates were incubated at 37°C for 24-48 hours. Deep red colonies surrounded by a narrow white zone was enumerated as Streptococcus faecalis.

(iv) Total mould count : Potato dextrose agar medium was used for total mould count. The composition of the medium is as follows:

Potato infusion	200 ml
Dextrose	20 gm
Agar	15 gm
Distilled water	800 ml

Sterilize at 15 lbs pressure/15 minutes.

Potato infusion was prepared by boiling 200 gm peeled and sliced potato in a liter of distilled water for one hour and strained through double thickness of clean towelling to get the infusion. Ten per cent tartaric acid solution was sterilized separately and was added to the medium just before plating so that the final pH of the medium should be adjusted to 3.5 ± 0.1. Then the petridishes were incubated at 25°C for 5 days for enumeration.

The samples of breast and leg meat after three months of storage in deep freeze at -10°C, were used to know the final microbial evaluation of total plate counts, Coliform counts, Streptococcus faecalis counts and total mould counts. The same methods and procedures were adopted for final microbial evaluation as was done for initial microbial evaluation. The same techniques were repeated for chicken adults, chicken broilers and duck adults.

4. Effect of scalding on organoleptic properties of poultry meat

Organoleptic properties such as appearance, flavour, tenderness, juiceness and acceptability of poultry meat after 3 months deep freezing at $-10^{o}C$ was studied. For this a semi-trained taste panel was used. The samples were evaluated using "Haedonic scale" method. The haedonic scores ranged from 1 to 9 as indicated in Appendix - III.

To conduct the experiments, meat samples were obtained from deep freeze. Then the samples were thawed in refrigerator ($4^{o} \pm 1^{o}C$) for 16 hours. Each sample was identified according to the number already present in it. For each experimental treatment there were 5 breast meat and 5 leg meat samples in case of chicken (both adult and broiler age group), but for duck adults, there were three breast meat and two leg meat samples. The meat samples were cooked using 1.5% saline solution in autoclave at $121^{o}C$ for 15 minutes. After cooking each meat sample was made into small cubic pieces of uniform and equal sizes. These pieces were presented at the sensory evaluation laboratory of the depa-rtment to taste panel members. For chicken adults and chi-cken broilers six judges attended, but for duck adults five judges attended. Each sample was given in duplicate to every judge by using code numbers for each meat sample. By this way, 60 observations were made for both breast and leg meat in case of chicken (both age groups) but only 30 and 20 observations were made for breast and leg meat respecti-vely in case of duck adults. At the end of the trial the results were analysed as per Duncan's Multiple Range Test and results were interpreted.

* CHAPTER IV *

* CHAPTER IV *

RESULTS AND DISCUSSION

1. Standardization of scalding techniques in different species of poultry

(a) Chicken : The effect of scalding techniques on slaughter data in case of adult chicken has been shown in Table 1 (a, b and c). The mean live weight for different batches of adult chickens taken for the study ranged from 1451 ± 75.065 gms to 1712 ± 83.066 gms just before slaughter. Weight after bleeding varied from 1405.5 ± 76.119 gms to 1660.5 ± 81.235 gms. This showed that blood weight is around 33.5 ± 2.795 gms to 54 ± 3.401 gms or 2.04 % to 3.30% of their live weight. The amount of blood lost is slightly lower than the results reported by Mountney(1976), Jull (1951) and Panda (1971, 1973) who stated it to be 3.3% to 4.8%. The feather weight was from 3.87% to 6.86% of the live weight. These values were consistent with reports already published by Mountney (1976), Jull (1951) and Panda (1971, 1973) who also stated it to be within the range of 4.5 to 8.5% of the live weight of the birds. Eviscerated weight before final washing was between 57.33% to 61.03% of their live weight whereas it was 59.01% to 62.63% after final washing. This increase in weight was perhaps due

Table 1. Effect of scalding techniques on slaughter data
Chicken adult age group
(a) Dressing - total and percent yield. (Mean ± S.E.)
Dressing yield (gms) and percent yield (within parentheses)

Particulars	Experimental treatments								
	77°C/60 sec	77°C/90 sec	77°C/120 sec	60°C/60 sec	60°C/90 sec	60°C/120 sec	53°C/60 sec	53°C/90 sec	53°C/120 sec
1	2	3	4	5	6	7	8	9	10
1. Live weight	1547.20 ± 77.22	1644.000 ± 61.565	1635.00 ± 58.26	1451.000 ± 78.065	1641.000 ± 67.435	1595.000 ± 99.279	1595.000 ± 42.776	1504.000 ± 75.408	1712.000 ± 83.066
2. Weight after bleeding	1560.200 ± 75.922 (96.96)	1610.500 ± 61.301 (97.96)	1581.000 ± 56.814 (96.7)	1405.500 ± 76.119 (96.86)	1597.000 ± 66.565 (97.32)	1549.000 ± 96.856 (97.12)	1546.000 ± 42.775 (96.93)	1460.000 ± 74.529 (97.07)	1660.500 ± 81.235 (96.99)
Blood weight	47.000 ± 1.528 (3.04)	33.500 ± 2.795 (2.04)	54.000 ± 3.401 (3.30)	45.500 ± 3.373 (3.14)	44.000 ± 4.764 (2.68)	46.000 ± 6.407 (2.88)	49.000 ± 2.77 (3.07)	44.000 ± 2.212 (2.93)	51.500 ± 1.98 (3.01)
3. Weight after defeathering	1410.900 ± 72.234 (91.19)	1509.200 ± 57.386 (91.80)	1517.800 ± 56.006 (92.83)	1313.000 ± 73.018 (90.49)	1501.500 ± 65.57 (91.5)	1476.400 ± 89.091 (92.56)	1475.200 ± 38.781 (92.49)	1388.100 ± 72.448 (92.29)	1573.400 ± 81.658 (91.90)
Feather weight	89.3 ± 6.9 (5.77)	101.300 ± 4.994 (6.16)	63.200 ± 4.351 (3.87)	99.600 ± 10.828 (6.86)	91.500 ± 5.293 (5.58)	70.200 ± 8.884 (4.40)	69.100 ± 7.336 (4.33)	71.900 ± 4.869 (4.78)	87.100 ± 9.726 (5.09)
4. Eviscerated weight	887.000 ± 52.89 (57.33)	971.000 ± 36.475 (59.06)	997.800 ± 35.339 (61.03)	885.200 ± 43.476 (61.01)	987.500 ± 44.562 (60.18)	961.700 ± 60.105 (60.29)	951.500 ± 28.54 (59.66)	894.500 ± 46.115 (59.47)	1024.300 ± 45.955 (59.83)
i) Visceral content	322.50 ± 17.77 (20.84)	334.900 ± 29.791 (20.37)	309.500 ± 17.795 (18.93)	243.400 ± 34.867 (16.77)	297.100 ± 29.134 (18.10)	306.800 ± 23.646 (19.24)	314.200 ± 13.076 (19.70)	300.000 ± 21.017 (19.95)	324.500 ± 38.498 (18.95)

continued...

Table 1(a) continued...

1	2	3	4	5	6	7	8	9	10
ii) Weight of giblets	70.30 ± 2.55 (4.54)	69.300 ± 2.325 (4.22)	71.70 ± 2.71 (4.39)	63.700 ± 3.042 (4.39)	70.500 ± 2.355 (4.30)	71.900 ± 3.652 (4.51)	73.70 ± 2.66 (4.62)	74.800 ± 4.442 (4.97)	68.200 ± 1.673 (3.98)
5. i) Weight of Head	74.40 ± 3.52 (4.81)	65.600 ± 2.787 (3.99)	59.700 ± 2.626 (3.65)	61.100 ± 1.684 (4.21)	77.600 ± 3.821 (4.73)	65.300 ± 3.466 (4.09)	69.800 ± 2.757 (4.38)	60.600 ± 5.111 (4.03)	83.300 ± 5.417 (4.87)
ii) Weight of neck	63.40 ± 3.16 (4.10)	67.300 ± 2.034 (4.09)	70.500 ± 4.352 (4.31)	74.700 ± 4.063 (5.15)	75.300 ± 5.731 (4.59)	65.40 ± 4.97 (4.10)	74.000 ± 2.601 (4.64)	63.400 ± 4.033 (4.22)	67.000 ± 3.988 (3.91)
iii) Weight of feet	47.4 ± 2.0 (3.06)	46.400 ± 1.302 (2.82)	44.800 ± 1.444 (2.74)	43.200 ± 1.563 (2.98)	53.200 ± 3.124 (3.24)	44.100 ± 2.346 (2.76)	43.200 ± 1.666 (2.71)	40.700 ± 7.217 (2.71)	47.600 ± 1.985 (2.78)
6. Hot dressed weight (- giblets)	913.00 ± 54.85 (59.01)	995.500 ± 37.456 (60.55)	1022.800 ± 36.611 (62.56)	908.700 ± 44.687 (62.63)	1015.000 ± 45.773 (61.85)	986.700 ± 61.579 (61.86)	980.100 ± 29.627 (61.45)	922.300 ± 47.204 (61.32)	1055.00 ± 47.221 (61.62)
7. Cold dressed weight (- giblets)	891.80 ± 53.34 (57.64)	967.200 ± 36.605 (58.83)	983.700 ± 35.374 (60.17)	876.000 ± 42.606 (60.37)	968.200 ± 42.379 (59.00)	959.100 ± 60.246 (60.13)	960.500 ± 29.302 (60.22)	894.700 ± 46.229 (59.49)	1016.4 ± 45.5 (59.37)
8. Dressing percentage (hot dressed weight+giblets)	63.324 ± 0.701	64.933 ± 1.094	66.990 ± 0.557	67.390 ± 1.397	66.181 ± 1.284	66.483 ± 0.568	66.020 ± 0.958	66.352 ± 0.895	65.858 ± 1.044

Table 1 (b) Dressing percent in relation to live weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec	77°C/90 sec	77°C/120 sec	60°C/60 sec	60°C/90 sec	60°C/120 sec	53°C/60 sec	53°C/90 sec	53°C/120 sec
1. Hot dressed (- giblets)	58.703 ±0.815	60.637 ±1.092	62.574 ±0.571	62.925 ±1.366	61.857 ±1.313	61.904 ±0.631	61.457 ±0.960	61.353 ±0.913	61.788 ±0.961
2. Head	4.899 ±0.310	4.020 ±0.175	3.672 ±0.170	4.310 ±0.232	4.738 ±0.151	4.167 ±0.217	4.398 ±0.186	4.235 ±0.116	4.917 ±0.310
3. Legs	3.103 ±0.135	2.851 ±0.122	2.748 ±0.064	3.041 ±0.173	3.287 ±0.247	2.783 ±0.060	2.706 ±0.061	2.703 ±0.044	2.810 ±0.112
4. Carcass + neck	58.703 ±0.815	60.637 ±1.092	62.574 ±0.571	62.925 ±1.366	61.857 ±1.313	61.904 ±0.631	61.457 ±0.960	61.353 ±0.913	61.788 ±0.961
5. Giblets (a) Heart	0.808 ±0.063	0.442 ±0.019	0.498 ±0.035	0.499 ±0.043	0.579 ±0.033	0.709 ±0.196	0.564 ±0.036	0.622 ±0.032	0.603 ±0.023
(b) Liver	1.779 ±0.108	1.908 ±0.065	1.889 ±0.129	2.204 ±0.171	2.081 ±0.098	1.807 ±0.167	1.928 ±0.108	2.188 ±0.137	1.550 ±0.128
(c) Gizzard	2.030 ±0.094	1.887 ±0.091	2.026 ±0.124	1.759 ±0.108	1.661 ±0.064	2.060 ±0.097	2.132 ±0.091	2.186 ±0.149	1.915 ±0.117
Total :	4.620 ±0.214	4.239 ±0.129	4.415 ±0.183	4.464 ±0.253	4.322 ±0.120	4.578 ±0.195	4.626 ±0.131	4.998 ±0.216	4.070 ±0.219

continued...

Table 1 (c) Dressing percent in relation to dressed weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec	77°C/90 sec	77°C/120 sec	60°C/60 sec	60°C/90 sec	60°C/120 sec	53°C/60 sec	53°C/90 sec	53°C/120 sec
1. Chilled carcass plus neck	90.527 ±0.460	90.708 ±0.207	89.843 ±0.587	90.056 ±0.697	89.199 ±0.589	90.510 ±0.653	91.208 ±0.347	89.712 ±0.772	90.396 ±0.376
2. Total giblets	7.319 ±0.386	6.345 ±0.217	6.456 ±0.266	6.500 ±0.358	6.411 ±0.233	6.755 ±0.309	6.888 ±0.216	7.406 ±0.323	6.055 ±0.290
3. Total ready-to-cook weight	97.662 ±0.184	97.154 ±0.164	96.300 ±0.501	96.557 ±0.499	95.610 ±0.583	96.881 ±0.500	98.097 ±0.211	97.119 ±0.943	96.451 ±0.240

to water absorption which was 1.49% to 1.85% of the live weight. This appear to be slightly less than that which has been reported by Brant (1963). The variation in the result for water absorption due to washing may be owing to the different method of processing adopted. During washing the semi-scalded carcasses showed more water absorption as compared to hard-scalded and sub-scalded carcasses. It was in agreement with result of Thomason (1978),Wesley (1978) and James et al. (1950).

On the other hand, cold dressed weight (without giblets) was reduced in comparison to hot dressed weight (without giblets) after 24 hours of air chilling in refrigerator at $4^{o} \pm 1^{o}$C. The loss in weight due to air chilling ranged from 1.23% to 2.85% and it was more for higher scalding temperatures. Pool et al. (1954) also obtained similar results who concluded that the loss due to air chilling was 1.0 to 2.7%. Weight of giblets ranged from 4.07% to 4.99 %.

The total ready-to-cook weight or dressing percentage before chilling ranged from 63.324 (± 0.701) % to 67.39 (± 1.397) % . The said value was greatest for the scalding technique at 60^{o}C/60 sec. Snyder and Orr (1964), Jull (1943, 1951) and Sadasivam et al. (1980) were also of the same opinion. But the dressing percentage obtained was lower than the value reported by Panda and Sri Hari (1971), who reported 72.10 % for culled adult hens. Ranganathan et al. (1967) and Ranganathan and Pravakaran (1967-68) also indicated higher dressing percentage while using RIR and white rock adult birds. This might be due to breed and strain variation including method of processing especially chilling. While considering the loss of inedible parts, weight of head varied from 3.672 % to 4.917% and feet and shanks varied from 2.703 to 3.287 % of the live weight. The former weight was in agreement with the result of Jull et al. (1943) while the latter weight had lower value, since Jull et al. (1943) reported that the weight of shank and feet varied from 4.6 to 5.9% of live weight. The possible reason for the lower value of shank and feet might be due to kind and class of poultry. The total inedible parts varied from 24.5% to 30.316%. This result was little higher than the value shown by Kahle and Gray (1956) who reported the shrinkage from live to ready-to-cook weight to be 27.8% in chickens. Panda(1979) reported the waste in shape of blood, feathers, head, feet and viscera to be around 27 to 29 %.

The average dressing percentage for different scalding techniques is given in Table 2, which gives the best result in temperature-time combination of $60^{o}C/60$ sec. Statistical analysis to know the significant differences within the experimental treatments has also been given in Table 2. From the results, it is clear that the treatments $60^{o}C/60$ sec. and $77^{o}C/120$ sec. were significantly different than all other treatments, while there was no significant difference within the former two treatments. Since the dressing percentage of $60^{o}C/60$ sec. batch was higher than $77^{o}C/120$ sec., the former scalding technique is recommended for chickens of the adult age group.

The effect of scalding techniques on grading of ready-to-cook chicken is shown in Table 3. Since the processing of the birds was done by a indigenous manual technique, there was no distinguishable grading defects for the characters such as disjointed bones, broken bones and missing parts. Defects such as conformation, fleshing and fat covering were also less as the birds were from the same flock and age group and were managed under similar schedule. The main grading defects were seen for the characters like pin feathers (both nonprotruding and protruding pins) and cuts, tears and missing skin. The

Table 2. Effect of scalding techniques on dressing percent of chicken and duck adult age group (Mean ± S.E.)

Experimental treatments	Chicken	Duck
77°C/60 sec.	63.324[a] ± 0.701	61.942[a] ± 1.332
77°C/90 sec.	64.933[a] ± 1.094	64.282[b] ± 0.612
77°C/120 sec.	66.99[b] ± 0.557	65.625[b] ± 0.922
60°C/60 sec.	67.39[b] ± 1.397	62.387[a] ± 1.183
60°C/90 sec.	66.181[a] ± 1.284	60.871[a] ± 3.247
60°C/120 sec.	66.483[a] ± 0.568	67.675[b] ± 0.951
53°C/60 sec.	66.02[a] ± 0.958	66.377[b] ± 0.381
53°C/90 sec.	66.352[a] ± 0.895	65.362[b] ± 1.138
53°C/120 sec.	65.858[a] ± 1.044	63.323[a] ± 1.339

Figures with different superscripts differ significantly at $P < 0.05$.

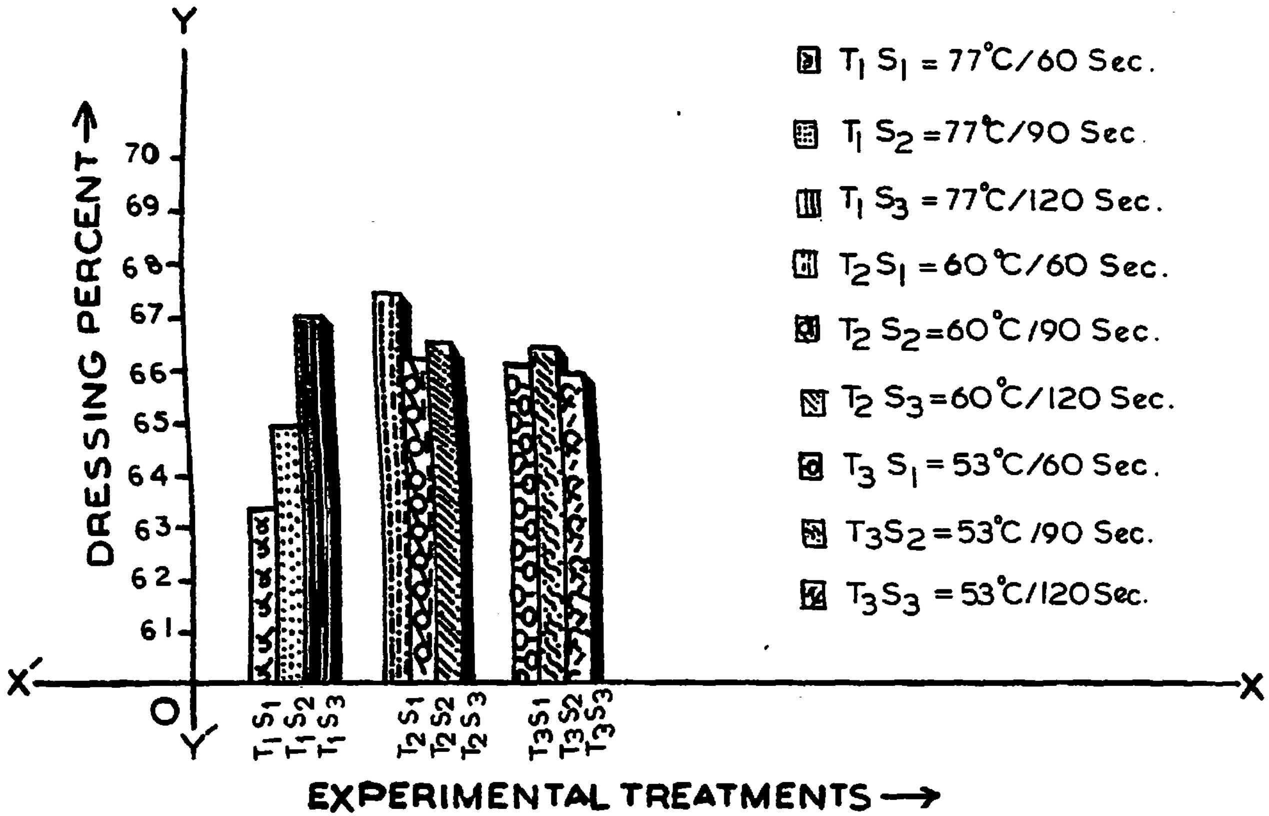


FIG-1. DRESSING PERCENT OF CHICKEN ADULT AGE GROUP.

Table 3. Effect of scalding techniques on grading of ready-to-cook chicken adult age group (in percentage of grade).

Characters 1	Grade 2	77°C/60 sec. 3	77°C/90 sec. 4	77°C/120 sec. 5	60°C/60 sec. 6	60°C/90 sec. 7	60°C/120 sec. 8	53°C/60 sec. 9	53°C/90 sec. 10	53°C/120 sec. 11
1. Conformation:										
Breast bone	A	30	90	60	50	70	70	80	30	70
	B	60	10	40	40	30	30	20	60	20
	C	10	0	0	10	0	0	0	10	10
Back	A	30	50	40	60	90	10	80	10	70
	B	60	50	60	40	10	80	20	50	20
	C	10	0	0	0	0	10	0	40	10
Legs and wings	A	30	50	10	60	60	20	80	10	70
	B	60	50	80	40	40	80	20	40	20
	C	10	0	10	0	0	0	0	50	10
2. Fleshing	A	30	40	50	60	80	60	80	30	70
	B	70	60	50	40	20	40	20	70	20
	C	0	0	0	0	0	0	0	0	10
3. Fat covering	A	30	0	0	60	80	10	80	30	70
	B	70	100	100	40	20	80	20	70	20
	C	0	0	0	0	0	10	0	0	10
4. Pin feathers:	A	90	30	40	0	0	0	0	0	0
Nonprotruding pins and hair	B	10	70	60	20	90	80	10	0	0
	C	0	0	0	80	10	20	90	100	100

continued...

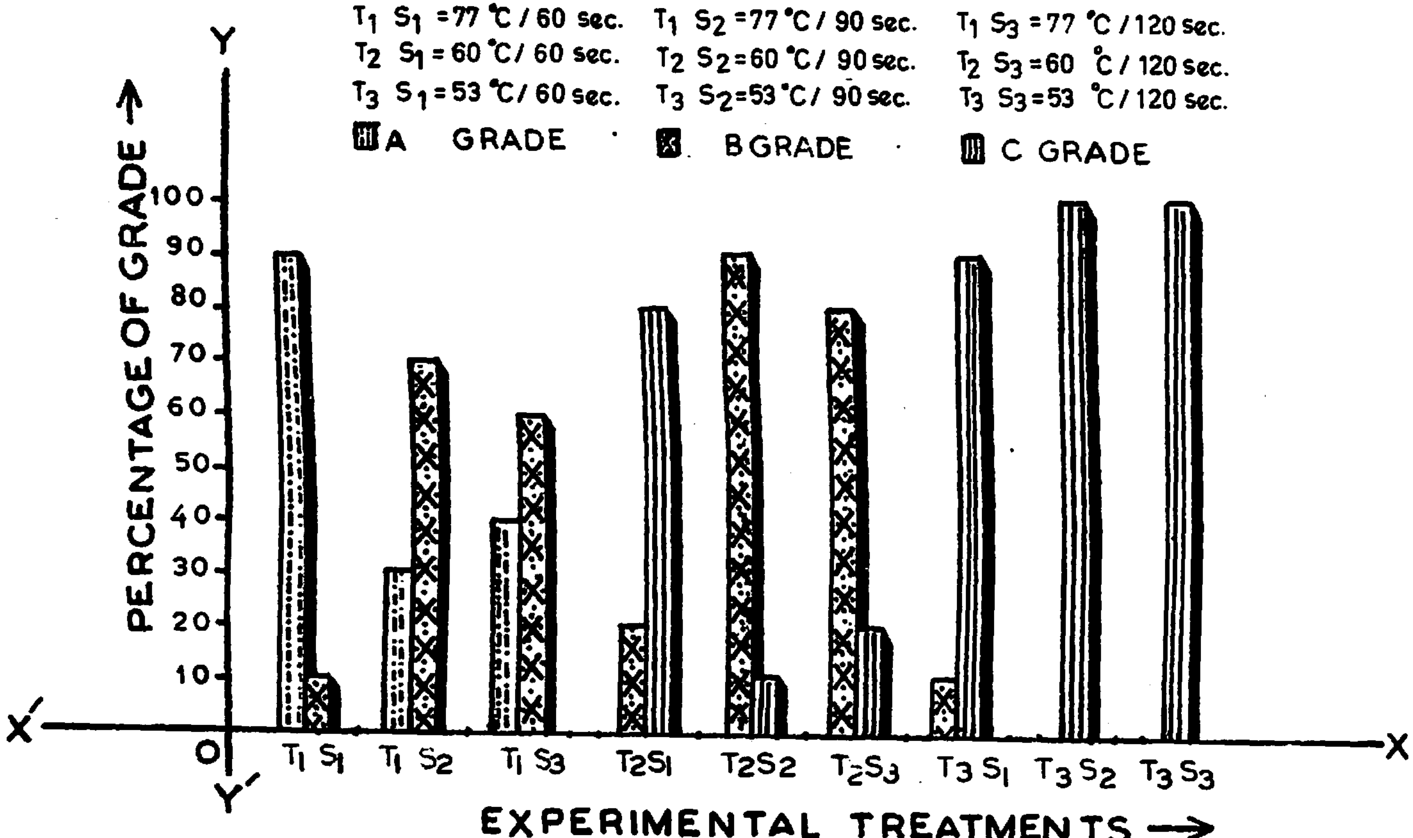
Table 3(continued)....

1	2	3	4	5	6	7	8	9	10	11
Protruding pins	A	10	70	70	10	0	0	0	0	0
	B	60	30	30	70	50	60	10	20	30
	C	30	0	0	20	50	40	90	80	70
5. Cuts, tears, missing skin	A	0	5	5	60	40	0	40	45	55
	B	40	30	25	30	20	15	10	10	20
	C	60	65	70	10	40	85	50	40	25
6. Discolourations	A	80	100	0	80	70	10	0	0	10
	B	20	0	10	20	30	90	90	80	70
	C	0	0	90	0	0	0	10	20	20
7. Disjointed bones	A	90	100	100	100	100	100	100	100	100
	B	10	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0
8. Broken bones	A	80	100	100	70	90	90	100	100	60
	B	10	0	0	30	10	10	0	0	40
	C	10	0	0	0	0	0	0	0	0
9. Missing parts	A	100	100	90	100	100	100	100	100	100
	B	0	0	10	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0

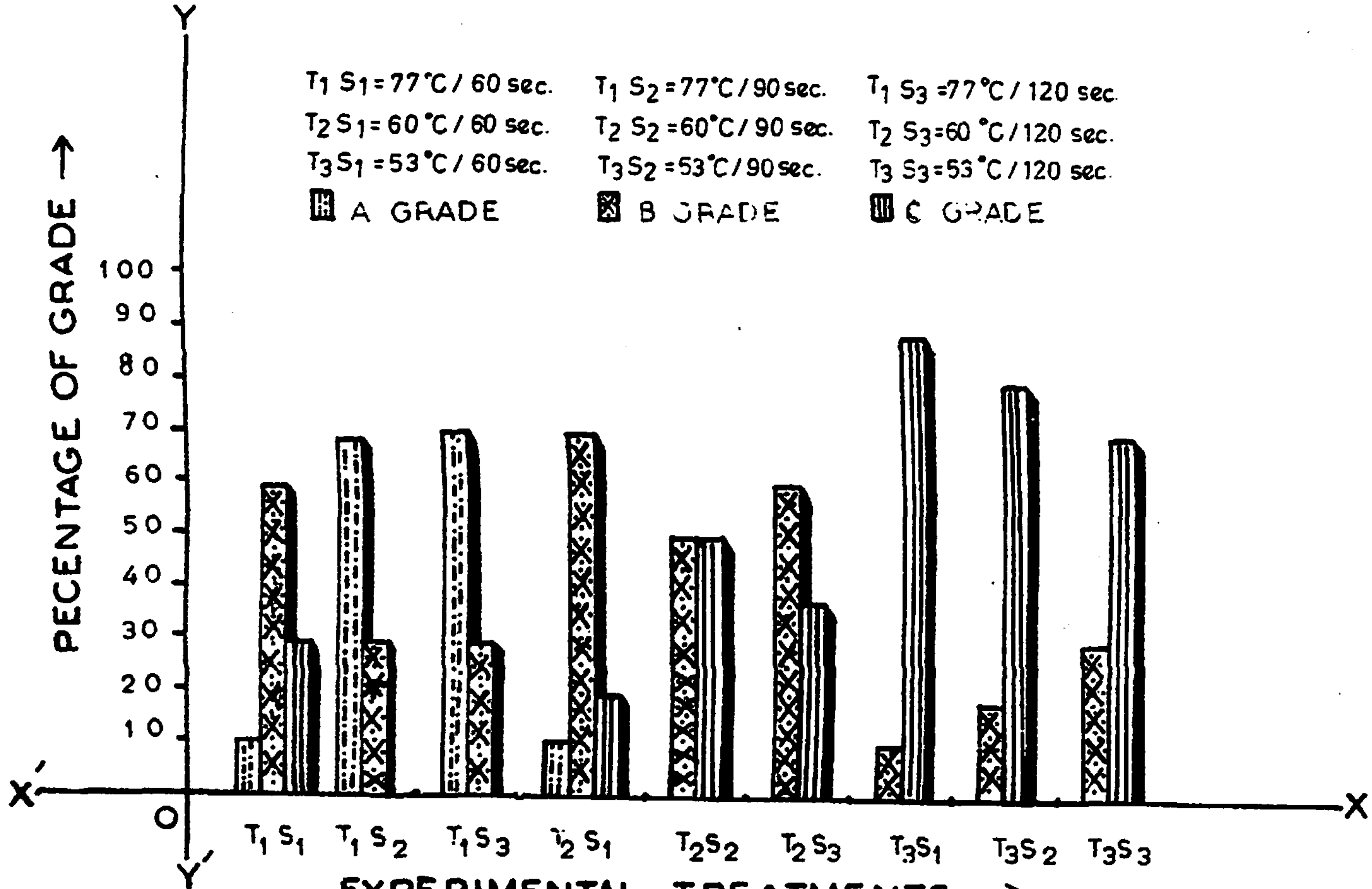
salient grading defects responsible for downgrading the carcasses are noted in Table 4. The grading defects are presented as percentage of A, B or C grade. That means more A grade % pertains to less defect and in reverse more C grade % of carcass expresses the more defect due to grading. For nonprotruding pins and hair and protruding pin, the hard scalding treatments showed the least defect while those in sub-scalding treatments and semi-scalding treatments increased in that order. Definitely as concerned to pin feathers, high scalding temperature is preferable. On the other hand, while considerations are made to find out the defects for cuts, tears and missing skin in hard scalding treatments, the percentage of C grade carcasses was more as compared to sub-and semi-scalding treatments. For the character of cuts, tears and missing skin, the scalding treatment of 60°C/60 sec. was best as in this treatment, there were maximum A grade (60 %) and minimum C grade (10 %) carcasses. From this, it can be concluded that scalding treatment of 60°C/60 sec. would work out better for chicken of adult age group while processing. The more number of pin feathers in low scalding temperature has also been reported by Pearce and

Table 4. Effect of scalding techniques on grading defects of ready-to-cook chicken and duck adult age group (in percentage of grade).

Species/ characters	Grade	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/12 sec.
<u>Chicken</u>:										
Nonprotruding pins and hair	A	90	30	40	0	0	0	0	0	0
	B	10	70	60	20	90	80	10	0	0
	C	0	0	0	80	10	20	90	100	100
Protruding pins	A	10	70	70	10	0	0	0	0	0
	B	60	30	30	70	50	60	10	20	30
	C	30	0	0	20	50	40	90	80	70
Cuts, tears, missing skin	A	0	5	5	60	40	0	40	45	55
	B	40	30	25	30	20	15	10	15	20
	C	60	65	70	10	40	85	50	40	25
<u>Duck</u>:										
Nonprotruding pins and hair	A	90	80	70	30	40	50	10	20	25
	B	10	20	30	20	30	40	20	30	50
	C	0	0	0	50	30	10	70	50	25
Protruding pins	A	95	85	75	35	45	60	5	10	15
	B	5	10	15	60	40	30	20	30	40
	C	0	5	10	5	15	10	75	60	45
Cuts, tears, missing skin	A	0	0	0	30	40	50	60	70	75
	B	90	85	80	15	25	40	30	15	10
	C	10	15	20	55	35	10	10	15	15



FIG—2. GRADING DEFECTS IN CHICKEN ADULT AGE GROUP: NON-PROTRUDING PINS & HAIR.



FIG–3. GRADING DEFECTS IN CHICKEN ADULT AGE GROUP: PROTRUDING PINS.

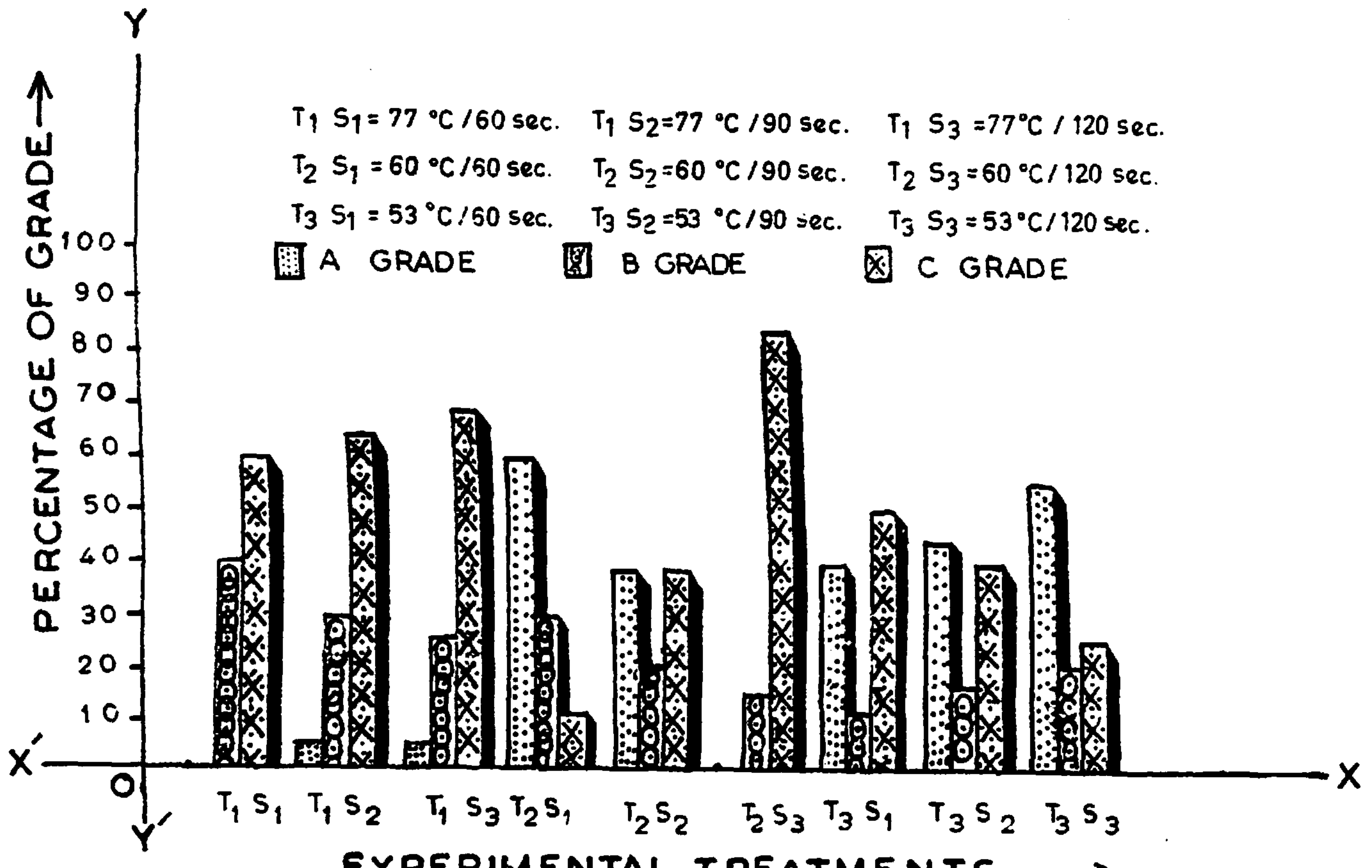


FIG-4. GRADING DEFECTS IN CHICKEN ADULT AGE GROUP: CUTS, TEARS & MISSING SKIN.

Lavers (1949), Knapp and Newell (1961) and Klose *et al*. (1961). The requirement of pin-free finished product for consumer appeal has been stressed by Gwin (1950, 1951 a, b, 1952). The bad effect of hard scalding, mis-handling and picking has also been projected by Mountney (1976) in his report.

(b) Duck : Mini Kos ducks of adult age group was compared with White Leghorns of same age for species variation due to the effect of different scalding technique. In Table 5 (a, b and c), the effect of scalding techniques on slaughter data is given. It is evident from this table that the initial live weight before slaughter varied from 994 ± 28.036 gms to 1084 ± 41.666 gms. Weight after bleeding was reported to range from 93.54% to 94.97%. The percent loss of blood was seen to be 5.03 to 6.46. This was similar to the results published by Gupta *et al*.(1978) who also reported the blood weight in case of Pekin Ducks to be 5.27 % at 18 hrs of pre-slaughter fasting. This shows that this particular value was higher than chicken as shown by Mountney (1976), Jull (1951) and Panda (1971, 1973). The possible reasons can be explained based on the reasoning given by the above workers, who concluded

Table 5. Effect of scalding techniques on slaughter data
Duck adult age group.
(a) Dressing - total and percent yield (Mean ± S.E.)

Dressing yield (gms) and percent yield (within parentheses)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1	2	3	4	5	6	7	8	9	10
1. Live weight	1022.000 ± 33.377	1012.000 ± 59.951	1000.000 ± 22.361	1084.000 ± 41.666	1008.000 ± 39.926	1062.000 ± 38.653	1006.000 ± 50.881	994.000 ± 28.036	1011.000 ± 23.474
2. Weight after bleeding	966.000 ± 29.934 (94.52)	960.000 ± 61.727 (94.86)	944.000 ± 23.152 (94.4)	1014.000 ± 29.428 (93.54)	954.000 ± 38.027 (94.64)	1008.000 ± 41.762 (94.92)	954.000 ± 53.443 (94.83)	944.000 ± 21.119 (94.97)	960.000 ± 21.213 (94.96)
Blood weight	56.000 ± 5.099 (5.48)	52.00 ± 2.00 (5.14)	56.00 ± 6.00 (5.6)	70.000 ± 15.811 (6.46)	54.000 ± 2.449 (5.36)	54.00 ± 4.00 (5.08)	52.000 ± 6.633 (5.17)	50.000 ± 8.366 (5.03)	51.000 ± 5.099 (5.04)
3. Weight after defeathering	903.000 ± 30.562 (88.36)	915.000 ± 55.228 (90.42)	890.60 ± 21.94 (89.06)	957.000 ± 34.446 (88.28)	890.000 ± 35.427 (38.29)	947.000 ± 42.864 (89.17)	914.000 ± 49.128 (90.85)	882.000 ± 18.682 (88.73)	904.000 ± 21.354 (89.42)
Feather weight	63.00 ± 2.0 (6.16)	45.000 ± 6.708 (4.45)	53.400 ± 12.351 (5.34)	57.000 ± 11.247 (5.26)	64.000 ± 6.403 (6.35)	80.600 ± 22.844 (7.59)	40.000 ± 5.244 (3.98)	62.000 ± 4.359 (6.24)	56.00 ± 1.00 (5.54)
4. Eviscerated weight	549.400 ± 24.584 (58.16)	558.600 ± 31.201 (55.20)	556.000 ± 22.592 (55.6)	586.000 ± 19.711 (54.06)	537.400 ± 42.659 (53.31)	623.000 ± 21.886 (58.66)	563.800 ± 33.205 (56.04)	550.600 ± 15.390 (55.39)	551.400 ± 19.493 (54.54)
i) Visceral content	173.400 ± 14.767 (16.97)	173.000 ± 15.215 (17.09)	140.000 ± 14.405 (14.0)	188.000 ± 15.215 (17.34)	194.000 ± 37.895 (19.25)	144.000 ± 19.837 (13.56)	152.400 ± 9.553 (15.15)	161.400 ± 14.473 (16.24)	164.000 ± 12.186 (16.22)

continued...

Table 5(a) continued...

1	2	3	4	5	6	7	8	9	10
ii) Weight of giblets	62.800 ± 1.772 (6.14)	64.200 ± 3.929 (6.34)	78.000 ± 16.306 (7.8)	64.000 ± 2.701 (5.9)	52.200 ± 2.289 (5.18)	60.000 ± 1.140 (5.65)	65.000 ± 3.924 (6.46)	63.000 ± 2.626 (6.34)	57.400 ± 4.781 (5.68)
5. i) Weight of Head	65.400 ± 2.482 (6.40)	71.400 ± 2.731 (7.06)	70.000 ± 1.581 (7.0)	68.000 ± 1.224 (6.27)	63.000 ± 3.741 (6.25)	64.000 ± 2.449 (6.03)	71.800 ± 2.518 (7.14)	72.400 ± 1.661 (7.28)	70.000 ± 3.162 (6.92)
ii) Weight of neck	60.400 ± 3.558 (5.91)	65.600 ± 2.803 (6.48)	63.000 ± 4.626 (6.3)	62.000 ± 5.612 (5.72)	62.400 ± 8.140 (6.19)	72.000 ± 4.636 (6.78)	61.400 ± 4.057 (6.10)	58.600 ± 3.385 (5.90)	58.40 ± 3.40 (5.78)
iii) Weight of feet	26.400 ± 0.979 (2.58)	29.000 ± 1.378 (2.87)	28.400 ± 1.029 (2.84)	28.800 ± 1.241 (2.66)	24.400 ± 1.691 (2.42)	26.00 ± 1.00 (2.45)	26.4000 ± 0.979 (2.62)	22.800 ± 5.739 (2.29)	26.800 ± 0.916 (2.65)
6. Hot dressed weight (- giblets)	570.400 ± 23.941 (55.81)	585.400 ± 32.461 (57.85)	580.000 ± 21.909 (58.00)	611.000 ± 17.847 (56.37)	562.000 ± 43.001 (55.75)	658.000 ± 21.599 (61.96)	602.000 ± 33.553 (59.84)	586.000 ± 13.820 (58.95)	583.000 ± 19.532 (57.67)
7. Cold dressed weight (- giblets)	533.400 ± 26.136 (52.19)	550.800 ± 31.877 (54.43)	524.600 ± 22.013 (52.46)	581.000 ± 18.398 (53.60)	530.000 ± 43.561 (52.58)	621.000 ± 20.881 (58.47)	560.400 ± 33.937 (55.71)	549.600 ± 14.39 (55.29)	556.000 ± 19.50 (55.00)
8. Dressing percentage (hot dressed weight + giblets)	61.942 ± 1.332	64.282 ± 0.612	65.625 ± 0.922	62.387 ± 1.183	60.871 ± 3.247	67.675 ± 0.951	66.377 ± 0.381	65.362 ± 1.138	63.323 ± 1.339

Table 5 (b). Dressing percent in relation to live weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1. Hot-dressed (- giblets)	55.786 ±1.314	57.913 ±0.444	57.934 ±1.153	56.477 ±1.074	55.658 ±3.085	62.008 ±0.894	59.916 ±0.314	59.026 ±1.097	57.673 ±1.420
2. Head	6.404 ±0.185	7.119 ±0.344	7.008 ±0.177	6.296 ±0.173	6.263 ±0.37	6.033 ±0.168	7.18 ±0.21	7.288 ±0.087	6.948 ±0.392
3. Legs	2.603 ±0.172	2.878 ±0.083	2.843 ±0.11	2.657 ±0.066	2.409 ±0.076	2.46 ±0.126	2.641 ±0.094	2.899 ±0.042	2.654 ±0.094
4. Carcass plus neck	55.786 ±1.314	57.913 ±0.444	57.934 ±1.153	56.477 ±1.074	55.658 ±3.085	62.008 ±0.894	59.916 ±0.314	59.026 ±1.097	57.673 ±1.42
5. Giblets									
a) Heart	0.915 ±0.062	1.039 ±0.063	1.797 ±0.788	0.921 ±0.024	0.780 ±0.064	0.876 ±0.076	1.044 ±0.058	0.927 ±0.023	0.949 ±0.016
b) Liver	2.261 ±0.188	2.242 ±0.543	3.286 ±0.891	2.408 ±0.13	2.205 ±0.242	2.145 ±0.103	2.598 ±0.105	2.45 ±0.168	2.359 ±0.26
c) Gizzard	2.977 ±0.263	2.652 ±0.134	2.795 ±0.232	2.575 ±0.115	2.225 ±0.09	2.643 ±0.12	2.816 ±0.123	2.958 ±0.155	2.34 ±0.163
Total :	6.155 ±0.154	6.368 ±0.273	7.879 ±1.782	5.909 ±0.166	5.212 ±0.314	5.666 ±0.135	6.46 ±0.117	6.335 ±0.125	5.649 ±0.376

Table 5 (c) Dressing percent in relation to dressed weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1. Chilled carcass plus neck	84.102 ±0.868	84.724 ±0.607	81.529 ±2.594	86.061 ±0.482	86.05 ±0.853	86.468 ±0.332	83.887 ±0.576	84.674 ±0.618	86.855 ±0.667
2. Total giblets	9.513 ±0.318	9.503 ±0.368	11.351 ±2.364	9.118 ±0.165	8.167 ±0.400	7.924 ±0.142	9.283 ±0.134	9.238 ±0.244	8.569 ±0.621
3. Total ready-to-cook weight	93.616 ±0.634	94.228 ±0.444	92.881 ±0.344	95.18 ±0.457	94.218 ±0.674	94.393 ±0.321	93.171 ±0.528	91.913 ±1.794	95.425 ±0.152

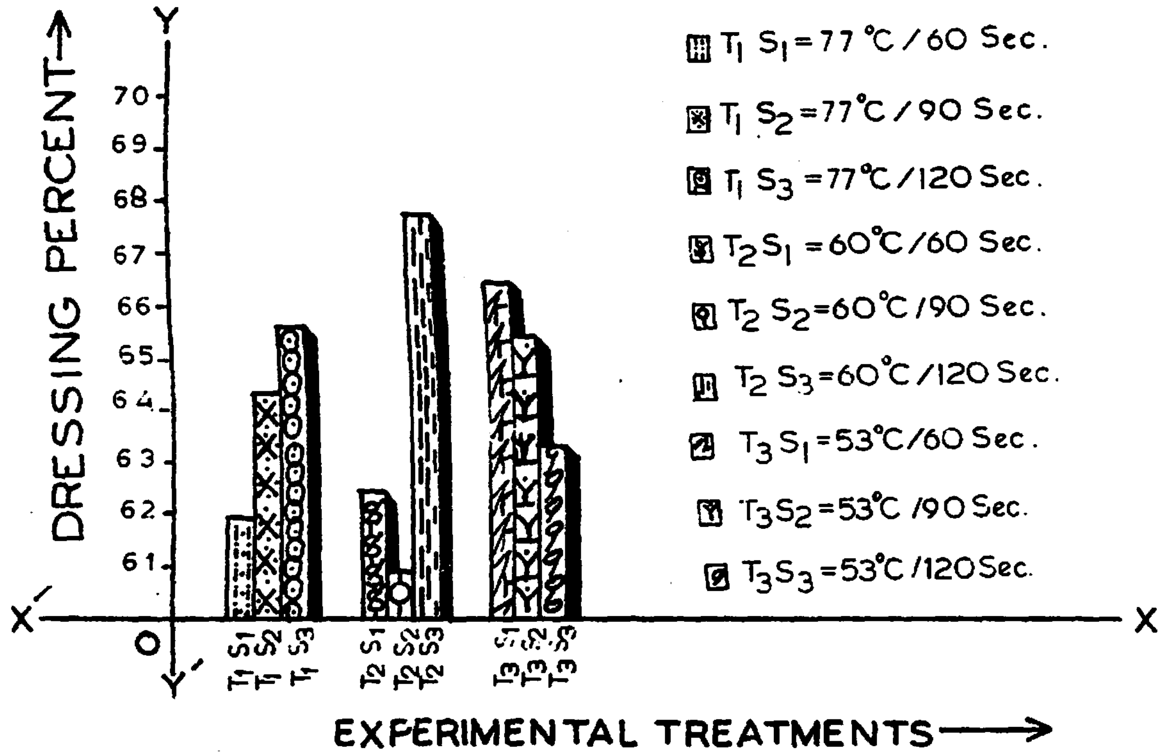


FIG-5. DRESSING PERCENT OF DUCK ADULT AGE GROUP.

that small birds loose relatively more blood in proportion to body weight than large birds. In the present study the defeathering weight ranged from 88.28% to 90.85% and feather weight from 3.98% to 7.59% of the live weight. This result is in agreement with the results shown by Mountney (1976). The feather weight in case of White Pekin was recorded to range from 6.14 to 6.71% by Gupta et al. (1978). Relatively a higher value was obtained in the present study for Mini Kos, in comparison to Pekin ducks. This might be due to poor conformation and stunted fleshing in Mini Kos. As the scalding time was increased, the percentage of feather weight obtained was increased in case of sub- and semi-scalding methods, but the same was not true in case of hard scalding technique. The percent yield of shank and head, and visceral content ranged from 8.32 to 10.15 and from 13.56 to 19.25 respectively. Gupta et al. (1978) observed the percentage of shank and head to be from 8.23% to 8.95% and the percentage of viscera to be from 6.29% to 7.52%. The difference in result might be due to breed difference. The giblets were found to fall within the range from 5.18% to 7.8%. Similar results were also obtained by Gupta et al. (1978) in case of Pekin ducks. While considering hot dressed weight (without giblets) and cold dressed weight (without giblets), the results varied from 55.75% to 61.96% and from 52.19% to 58.47%. Thus it indicated the weight loss due to the effect of air chilling to be from 2.67% to 5.54%. Moisture loss was more in case of higher scalding temperature and less in lower scalding temperature. Pool _et_ _al_. (1954) were also of the same opinion. Dressing percentage in duck, as already mentioned in Table 2, varied from 60.87 $\pm$ 3.247 % to 67.675 $\pm$ 0.951 % and the highest dressing percentage was obtained in case of the treatment 60°C/120 sec. Recently Gupta _et_ _al_. (1978) reported that in White Pekin ducks the ready-to-cook yield ranged between 68.36% to 70.49% and Mountney (1976) was of the opinion that the same to be around 70.3%. The relatively lower value reported in present study might be due to breed difference. Statistical analysis also showed the scalding treatment of 60°C/120 sec. to be significantly different from other sub-scalding methods viz. 60°C/60 sec. and 60°C/90 sec. But, it shows nonsignificant difference with 77°C/90 sec., 77°C/120 sec., 53°C/60 sec. and 53°C/90 sec. Yet, 60°C/120 sec. must be recommended as it gives the highest dressing percentage.

Effect of different scalding techniques on grading of ready-to-cook adult ducks is presented in Table 6. No much difference in the characters such as conformation, fleshing and fat covering could be seen as the birds were of the same breed, age and reared under similar schedule of management. Disjointed bones, broken bones and missing parts due to different scalding techniques was also negligible as processing of ducks were done by a manual indigenous method. The main defects were found for carcass characters such as pin feathers, cuts, tears and missing skin. This is presented in Table 4. The grading defects are presented as percentage of A, B and C grade carcasses. The interpretation is based on higher percentage of A grade carcasses which means the less of grading defects and the reverse is true for higher percentage of C grade carcasses. Table 4 clearly points out that both nonprotruding pins, hair and protruding pins were less when the scalding temperature was more. Within the subscald treatments, 60°C/120 sec. gave the best result. While considering the defects due to cuts, tears and missing skin, maximum defects were found in case of hard

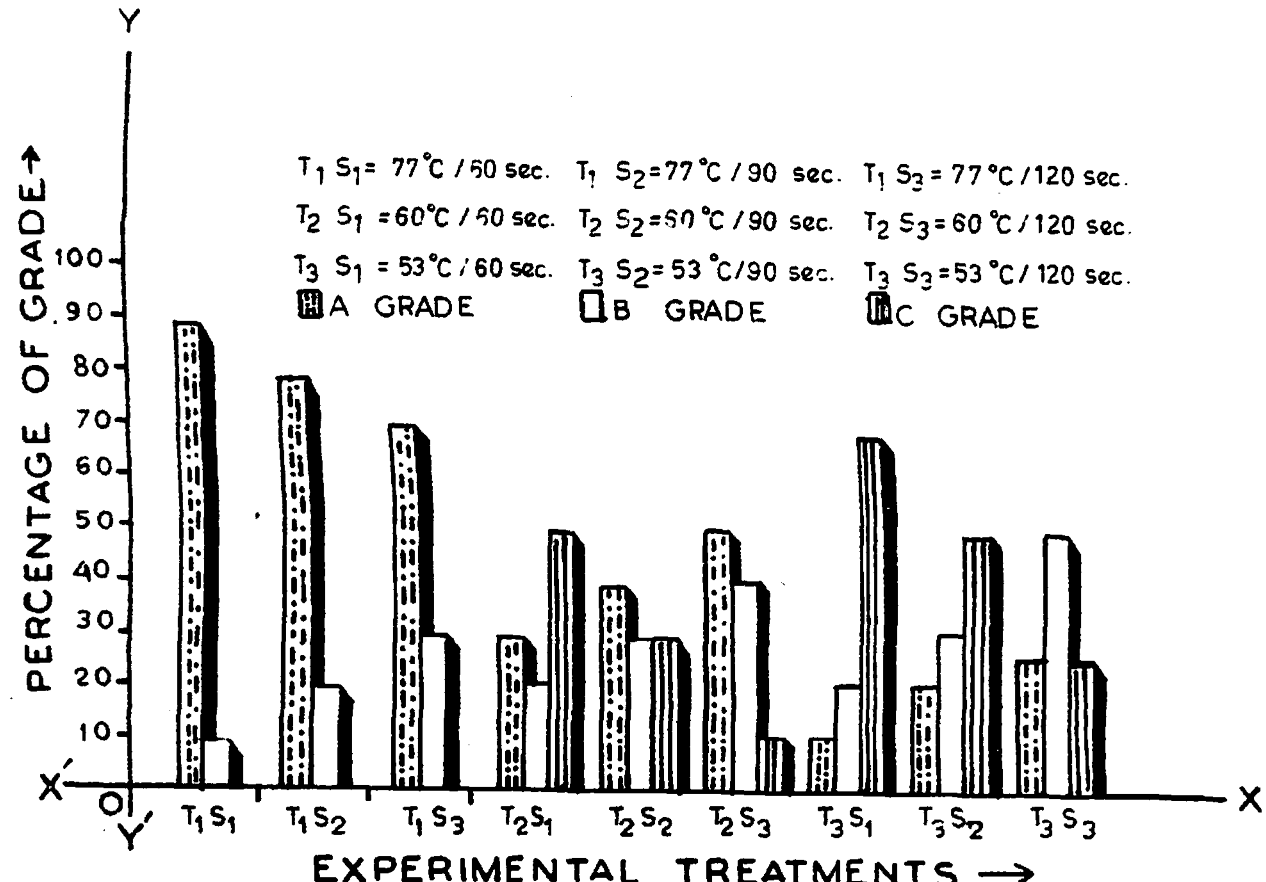
Table 6. Effect of scalding techniques on grading of ready-to-cook duck adult age group (in percentage of grade).

Characters 1	Grade 2	77°C/60 sec. 3	77°C/90 sec. 4	77°C/120 sec. 5	60°C/60 sec. 6	60°C/90 sec. 7	60°C/120 sec. 8	53°C/60 sec. 9	53°C/90 sec. 10	53°C/120 sec. 11
1. Conformation:										
Breast bone	A	5	5	10	5	0	10	5	5	5
	B	90	95	90	95	100	85	85	80	80
	C	5	0	0	0	0	5	10	15	15
Back	A	0	0	5	5	10	5	10	5	5
	B	90	90	95	95	90	85	80	80	95
	C	10	10	0	0	0	10	10	15	0
Legs and wings	A	0	5	5	10	10	5	5	15	10
	B	90	90	95	80	80	95	95	85	90
	C	10	5	0	10	10	0	0	0	0
2. Fleshing	A	0	0	0	5	10	5	10	0	0
	B	5	10	15	80	90	95	85	5	95
	C	95	90	85	15	0	0	5	95	5
3. Fat covering	A	0	0	5	0	5	10	10	0	0
	B	5	10	10	80	95	90	85	10	95
	C	95	90	85	20	0	0	5	90	5
4. Pin feathers:										
Nonprotruding pins and hair	A	90	80	70	30	40	50	10	10	25
	B	10	20	30	20	30	40	20	30	50
	C	0	0	0	50	30	10	70	60	25

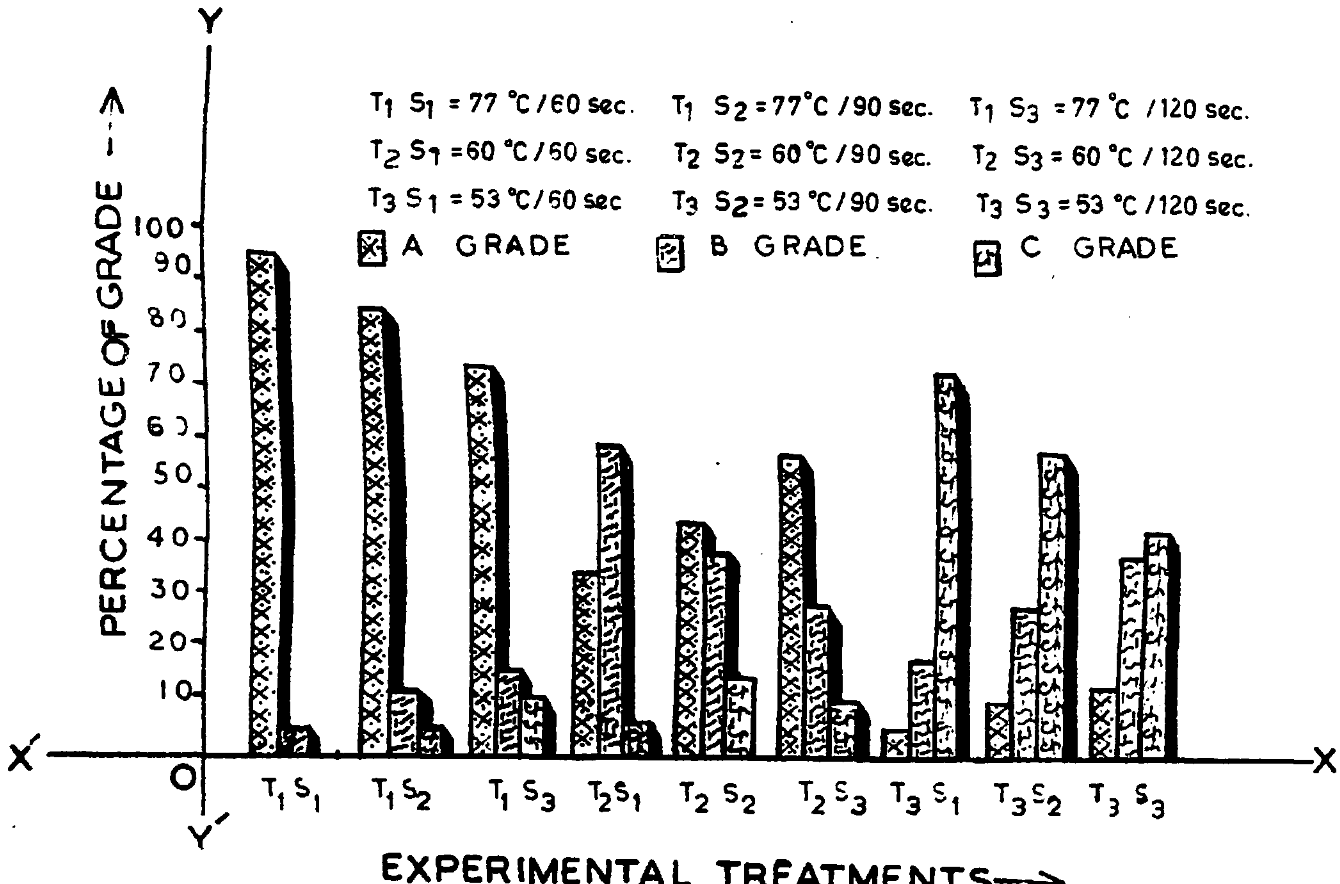
continued....

Table 6(continued)...

1	2	3	4	5	6	7	8	9	10	11
Protruding pins	A	95	85	75	35	45	60	5	10	15
	B	5	10	15	60	40	30	20	30	40
	C	0	5	10	5	15	10	75	60	45
5. Cuts, tears, missing skin	A	0	0	0	30	40	50	60	70	75
	B	90	85	80	15	25	40	30	15	10
	C	10	15	20	55	35	10	10	15	15
6. Discolourations	A	10	15	20	25	35	50	30	40	45
	B	70	65	50	60	55	45	55	40	30
	C	20	20	30	15	10	5	15	20	25
7. Disjointed bones	A	95	90	85	90	90	100	100	95	95
	B	5	10	15	10	10	0	0	5	5
	C	0	0	0	0	0	0	0	0	0
8. Broken bones	A	100	100	100	95	90	85	90	80	75
	B	0	0	0	5	10	15	10	20	20
	C	0	0	0	0	0	0	0	0	5
9. Missing parts	A	95	90	85	85	80	75	90	95	95
	B	5	10	15	15	20	25	10	5	5
	C	0	0	0	0	0	0	0	0	0



FIG—6. GRADING DEFECTS IN DUCK ADULT AGE GROUP: NON—PROTRUDING PINS & HAIR.



FIG—7. GRADING DEFECTS IN DUCK ADULT AGE GROUP: PROTRUDING PINS.

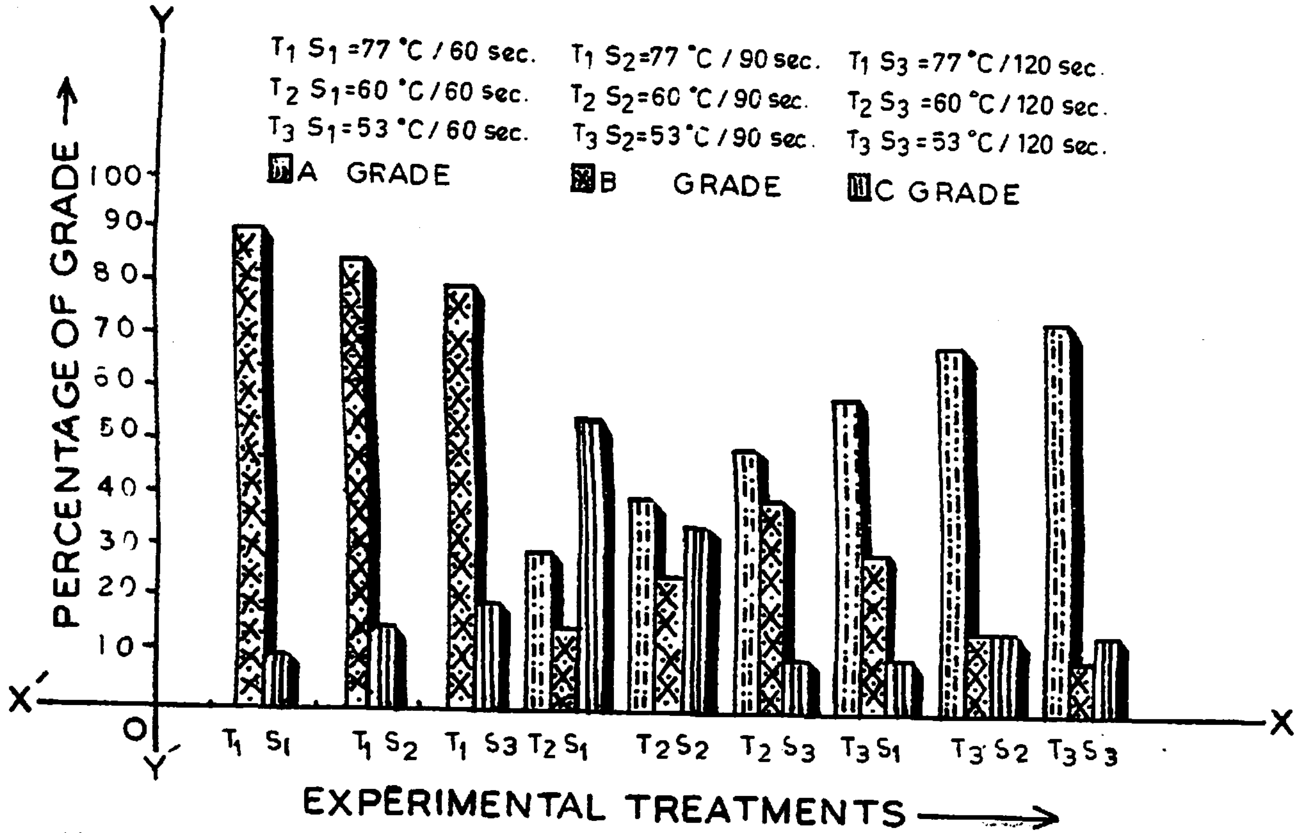


FIG-8 GRADING DEFECTS IN DUCK ADULT AGE GROUP: CUTS, TEARS & MISSING SKIN.

scalding treatments and minimum in case of semi-scalding treatments. Within sub-scalding treatments, 60°C/120 sec. showed the least defects for cuts, tears and missing skin. That is why 60°C/120 sec. can be considered better while comparing all other treatments. Adverse effect due to hard-scalding treatments has been reported by Pearce and Lavers (1949), Knapp and Newell (1961) and Klose *et al.* (1961). The consumer appeal for pin free sub-scald carcasses has been stressed by Gwin (1950, 1951 a, b and 1952).

2. Standardization of different scalding techniques for different age groups of poultry.

To study the effect of scalding techniques on different age groups of poultry, comparison was made between broiler age group and adult age group of chicken. Discussions with respect to scalding effects on meat yield and grading defects for adult age group of chicken have already been given. So, further discussions are limited only to the effect of age. The effect of scalding techniques on slaughter data for chicken broiler age group is shown in Table 7 (a, b and c). It is clear from this table that the initial live weight of male Arbor Acres

(a) Dressing - total and percent yield (Mean ± S.E.)
Dressing yield (gms) and percent yield (within parentheses)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/12 sec.
1. Live weight	1690.000 ± 54.485	1599.000 ± 77.521+	1653.000 ± 45.981	1853.000 ± 45.616	1939.000 ± 43.041	1793.000 ± 60.707	1851.00 ± 47.09	1943.000 ± 70.526	1987.00 ± 70.20
2. Weight after bleeding	1627.000 ± 51.871 (96.27)	1534.00 ± 75.82 (95.93)	1595.000 ± 42.854 (96.49)	1781.500 ± 44.341 (96.14)	1871.000 ± 42.047 (96.49)	1717.000 ± 58.161 (95.76)	1772.00 ± 46.6 (95.73)	1871.000 ± 70.009 (96.29)	1912.00 ±187.29 (96.23
Blood weight	63.000 ± 3.002 (3.73)	65.000 ± 4.016 (4.07)	58.00 ± 3.89 (3.51)	71.500 ± 4.478 (3.86)	69.000 ± 4.071 (3.56)	76.000 ± 3.714 (4.24)	79.000 ± 3.482 (4.27)	72.000 ± 2.001 (3.71)	75.00 ± 6.71 (3.77
3. Weight after defeathering	1503.000 ± 48.329 (88.93)	1411.500 ± 69.999 (88.27)	1477.000 ± 42.972 (89.35)	1660.900 ± 43.986 (89.63)	1756.200 ± 39.617 (90.56)	1620.000 ± 51.768 (90.35)	1657.000 ± 45.384 (89.52)	1747.300 ± 64.849 (89.93)	1783.00 ± 62.83 (89.73)
Feather weight	124.000 ± 5.816 (7.34)	122.500 ± 7.468 (7.66)	118.000 ± 3.817 (7.14)	120.600 ± 5.172 (6.51)	113.800 ± 4.397 (5.87)	97.000 ± 8.925 (5.41)	105.000 ± 5.531 (5.67)	123.700 ± 5.798 (6.37)	129.00 ± 9.39 (6.49)
4. Eviscerated weight	1004.500 ± 39.089 (59.44)	1028.700 ± 55.303 (64.33)	1057.100 ± 32.108 (63.95)	1221.700 ± 40.076 (65.93)	1273.900 ± 32.957 (65.70)	1167.000 ± 46.071 (65.09)	1113.5000 ± 37.806 (60.16)	1276.500 ± 49.206 (65.70)	1307.90 ± 54.35 (65.82
i) Weight of visceral content	151.500 ± 5.358 (8.96)	135.900 ± 8.071 (8.50)	152.100 ± 8.962 9.20	165.700 ± 6.782 8.94	187.700 ± 7.581 9.68	154.500 ± 5.894 8.62	156.500 ± 5.534 8.45	188.200 ± 8.648 9.69	183.50 ± 5.96 9.24

continued...

Table 7(a) continued...

1	2	3	4	5	6	7	8	9	10
ii)Weight of giblets	85.300 ± 2.125 (5.05)	82.700 ± 3.561 (5.17)	85.100 ± 1.992 (5.15)	90.500 ± 3.639 (4.88)	89.200 ± 3.469 (4.60)	88.500 ± 4.355 (4.94)	81.900 ± 2.917 (4.42)	88.200 ± 3.513 (4.54)	101.80 ± 3.71 (5.12)
5.i)Weight of Head	54.300 ± 1.184 (3.21)	52.500 ± 1.537 (3.28)	53.900 ± 1.697 (3.26)	64.200 ± 2.535 (3.46)	65.300 ± 1.096 (3.37)	58.100 ± 1.964 (3.24)	59.500 ± 2.168 (3.21)	60.500 ± 2.035 (3.11)	63.700 ± 2.496 (3.21)
ii)Weight of neck	91.500 ± 2.969 (5.41)	86.700 ± 5.358 (5.42)	87.700 ± 1.933 (5.31)	81.200 ± 2.539 (4.38)	96.900 ± 3.225 (5.00)	89.500 ± 4.377 (4.99)	90.000 ± 5.058 (4.86)	107.500 ± 5.789 (5.33)	97.200 ± 5.296 (4.89)
iii)Weight of feet	88.100 ± 2.515 (5.21)	84.900 ± 3.703 (5.31)	89.200 ± 2.251 (5.40)	97.700 ± 3.244 (5.27)	101.100 ± 2.341 (5.21)	96.400 ± 4.190 (5.38)	95.800 ± 3.77 (5.18)	108.700 ± 3.777 (5.59)	109.600 ± 4.321 (5.52)
6. Hot dressed weight (-giblets)	1030.000 ±39.994 (60.94)	1052.700 ±56.252 (66.21)	1082.700 ±32.904 (65.88)	1248.700 ±41.042 (67.35)	1308.000 ±33.888 (67.44)	1198.00 ±47.51 (66.79)	1140.00 ±38.44 (61.59)	1303.000 ±50.595 (67.05)	1332.800 ±55.871 (67.44)
7. Cold dressed weight (- giblets)	1005.700 ±37.915 (59.87)	1016.500 ±55.357 (63.53)	1049.000 ±31.617 (63.46)	1208.500 ±35.444 (65.18)	1275.00 ±32.87 (65.77)	1165.000 ±46.604 (64.95)	1118.6000 ±39.413 (60.39)	1274.300 ±49.448 (65.57)	1305.100 ±53.99 (65.66)
8. Dressing percentage(hot dressed + giblets)	65.906 ± 0.444	70.922 ± 0.49	70.629 ± 0.402	72.184 ± 0.742	72.03 ± 0.369	71.689 ± 0.435	65.925 ± 0.738	71.557 ± 0.411	72.105 ± 0.507

Table 7 (b) Dressing percent in relation to live weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1. Hot dressed (- giblets)	60.836 ±0.503	65.724 ±0.598	65.461 ±0.423	67.281 ±0.733	67.410 ±0.426	66.682 ±0.541	61.498 ±0.771	67.01 ±0.47	66.941 ±0.644
2. Head	3.23 ±0.083	3.222 ±0.119	3.266 ±0.077	3.47 ±0.133	3.378 ±0.076	3.257 ±0.103	3.223 ±0.120	3.126 ±0.083	3.225 ±0.132
3. Legs	5.226 ±0.094	5,327 ±0.107	5.385 ±0.126	5.276 ±0.149	5.218 ±0.082	5.369 ±0.127	5.173 ±0.155	5.612 ±0.147	5.519 ±0.132
4. Carcass plus neck	60.836 ±0.503	65.724 ±0.598	65.461 ±0.423	67.281 ±0.733	67.41 ±0.426	66.682 ±0.541	61.498 ±0.771	67.01 ±0.47	66.941 ±0.644
5. Giblets									
a) Heart	0.678 ±0.028	0.616 ±0.029	0.635 ±0.015	0.536 ±0.022	0.538 ±0.017	0.521 ±0.018	0.507 ±0.23	0.52 ±0.017	0.601 ±0.024
b) Liver	1.996 ±0.081	1.800 ±0.039	1.973 ±0.059	1.768 ±0.056	1.659 ±0.06	1.681 ±0.037	1.720 ±0.053	1.846 ±0.085	1.767 ±0.047
c) Gizzard	2.394 ±0.107	2.778 ±0.129	2.88 ±0.312	2.595 ±0.170	2.429 ±0.200	2.802 ±0.298	2.192 ±0.121	2.214 ±0.076	2.795 ±0.184
Total:	5.070 ±0.123	5.196 ±0.132	5.172 ±0.154	4.902 ±0.203	4.627 ±0.228	5.006 ±0.334	4.421 ±0.021	4.546 ±0.107	5.164 ±0.231

Table 7 (c) Dressing percent in relation to dressed weight (Mean ± S.E.)

Particulars	Experimental treatments								
	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1. Chilled carcass plus neck	90.154 ±0.432	89.436 ±0.424	89.800 ±0.452	90.303 ±0.659	91.215 ±0.331	90.374 ±0.408	91.491 ±0.361	91.617 ±0.146	90.911 ±0.406
2. Total giblets	7.503 ±0.207	7.119 ±0.222	7.109 ±0.212	6.607 ±0.267	6.193 ±0.303	6.802 ±0.439	6.513 ±0.216	6.101 ±0.146	6.896 ±0.327
3. Total ready-to-cook weight	97.665 ±0.374	96.555 ±0.309	96.868 ±0.419	96.911 ±0.552	97.409 ±0.092	97.24 ±0.161	98.005 ±0.273	97.768 ±0.170	97.808 ±0.197

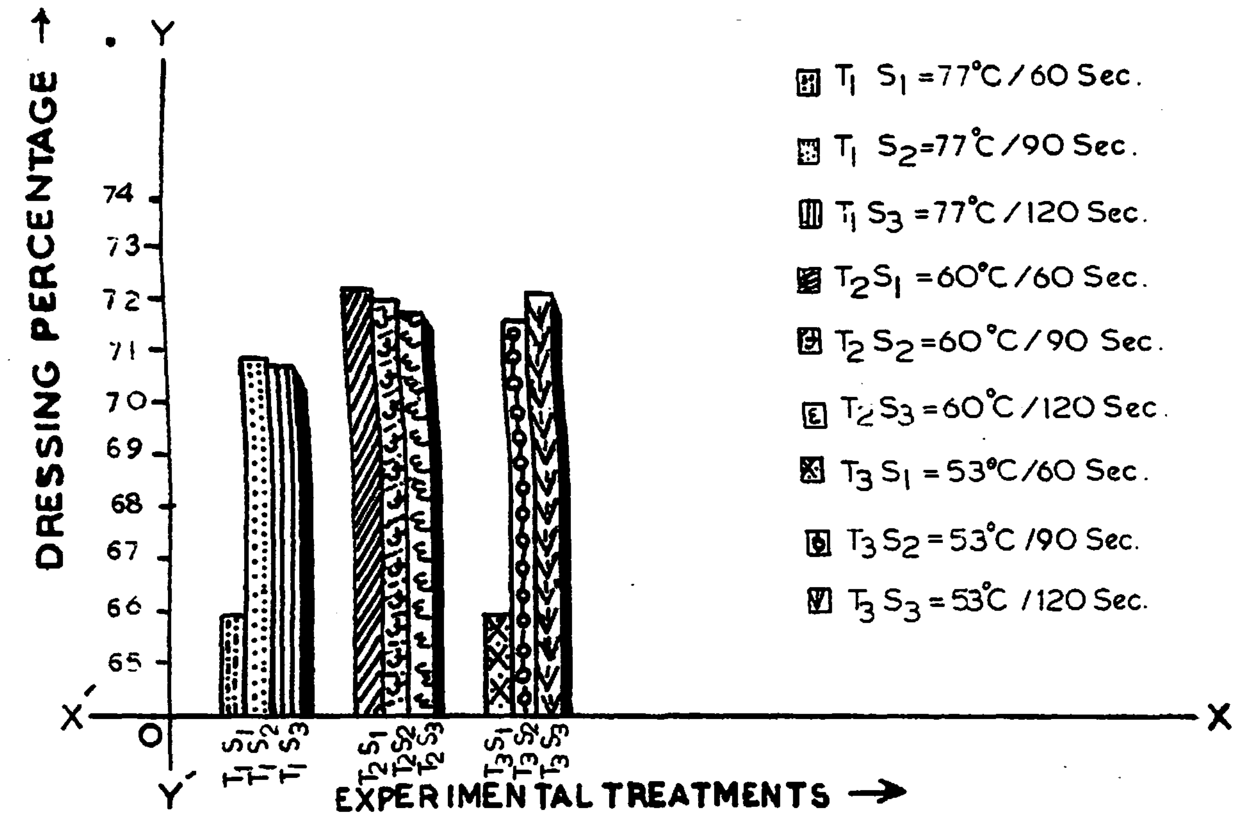
before slaughter ranged from 1599 $\pm$ 77.521 gms to 1987 $\pm$ 70.209 gms. Weight after bleeding was from 95.73% to 96.49% and blood weight was 3.51% to 4.27% of the live weight. Weight of blood lost in broilers in the present study is compatible with the results of Mountney (1976), Jull (1951) and Panda (1971, 1973) who also reported that the blood loss fell in the range from 3.3% to 4.8% for poultry. The same workers observed that the loss in shape of feathers to be 4.5% to 8.5% whereas in the present study feather weight loss was found to be from 5.41 to 7.66% of the live weight. This result was quite comparable with the results of the above mentioned workers. But the peculiarity found was that in hard scalding treatments, feather weight was increased as compared to sub-scalding and semi-scalding treatments and the reverse was true for weight after defeathering. The possible reason for this is that hard-scalding treatments adversely affect weight after defeathering, since it resulted in peeling skin patches off and increased abraisons.

Losses due to visceral contents, head and feet were in the range of 8.45 to 9.69%, from 3.11 to 3.46% and from 5.18 to 5.59% respectively. Snyder and Orr (1964) got head weight as 2.7% and feet as 5.3%. The head weight in present study was higher. The cause may be due to breed variation as Snyder and Orr (1964) observed their results for chicken broilers in general for all kinds of poultry. The visceral content in broilers was quite low as compared to chicken adult age group. It may be due to sex variation. Because the adult chickens were female and within their first year of laying whereas broilers were male Arbor Acres. Panda (1971) has already indicated that the visceral loss during dressing is usually less in male birds when compared to females. The weight of giblets varied from 4.421 ± 0.021 % to 5.196 ± 0.132% similar to the observations of Snyder and Orr (1964). The eviscerated weight of carcass of different batches varied from 59.44% to 65.93% and after washing it was from 60.94% to 67.44%. This increase in weight during washing was due to water absorption that ranged from 1.35% to 1.93%. During air chilling there was weight loss. After air chilling the cold carcass weight was from 59.87% to 65.77% and the moisture loss varied from 1.07 to 2.68%. The loss during air chilling increased in order of increasing scalding temperature. This result was comparable with that of Thomason (1979). The dressing percentage varied from 65.906 ($\pm$ 0.444) % to 72.184 ($\pm$ 0.742) %. The results observed for dressing percentage was in the range as reported by Jaap *et al.* (1950) and Mathur and Ahmed(1968). The results were similar to those obtained by Jull and Maw (1923), Vernon (1923), Lowe (1941) and Jull (1943), who stated it to be between 67% to 75%. Such variations might be due to the method of processing, breed differences and initial live weight in a particular age. Because the lighter birds yield less than the heavier ones even in the same age group as recorded by Mountney (1976). The data regarding mean dressing percentage influenced by different scalding techniques is presented in Table 8, for the comparison of chicken adult and broiler age groups. The results when analysed by Duncan's multiple range and multiple F test to discriminate the significant differences within different scalding treatments (Table 8), showed that the treatment of 53°C/120 sec. is significantly different from 53°C/60 sec. and 77°C/60 sec. While comparing the yield, the best yield is found in 60°C/60 sec. but sub-scald temperature cannot be recommended for broilers

Table 8. Effect of scalding techniques on dressing percent of chicken adult and broiler age groups (Mean ± S.E.)

Experimental treatments	Chicken(adults)	Chicken(broilers)
77°C/60 sec.	63.324[a] ± 0.701	65.906[a] ± 0.444
77°C/90 sec.	64.933[a] ± 1.094	70.922[b] ± 0.49
77°C/120 sec.	66.99[b] ± 0.557	70.629[b] ± 0.402
60°C/60 sec.	67.39[b] ± 1.397	72.184[b] ± 0.742
60°C/90 sec.	66.181[a] ± 1.284	72.038[b] ± 0.369
60°C/120 sec.	66.483[a] ± 0.568	71.689[b] ± 0.435
53°C/60 sec.	66.02[a] ± 0.958	65.925[a] ± 0.738
53°C/90 sec.	66.352[a] ± 0.895	71.557[b] ± 0.411
53°C/120 sec.	65.858[a] ± 1.044	72.105[b] ± 0.507

Figures with different superscripts differ significantly at $P < 0.05$.



FIG—9. DRESSING PERCENT OF CHICKEN BROILER AGE GROUP.

due to adverse effect on grading and carcass quality as numerous skin blemishes were detected when the above time-temperature combination was employed. The next highest yield was found in the scalding treatment of 53°C/120 sec. since this semi-scald temperature keeps the skin intact and has least effect on grading defects, it was considered to be the best. The effect of scalding techniques on grading of ready-to-cook chicken broiler age group is given in Table 9. Like chicken adult age group, in broilers also there is not much effect due to scalding treatments on grading characters such as conformation, fleshing, fat covering, as they were of the same age group belonging to only one strain and were reared under similar conditions of management. Question of defects like disjointed bones, broken bones and missing parts were also less as the processing of birds was done by a manual indigenous technique. The main grading defects found due to scalding effects were pin feathers and cuts, tears including missing skin (Table 10). Nonprotruding pins was less as the scalding temperature increased. The same was also found for protruding pins. This may be the cause of reduced feather pulling force parallel with higher

Table 9. Effect of scalding techniques on grading of ready-to-cook chicken broiler age group (in percentage of grade).

haracters	Grade	77°C/60 sec.	77°C/90 sec.	77°C/120 sec.	60°C/60 sec.	60°C/90 sec.	60°C/120 sec.	53°C/60 sec.	53°C/90 sec.	53°C/120 sec.
1	2	3	4	5	6	7	8	9	10	11
.Conformation:										
Breast bone	A	95	95	90	90	85	80	80	90	80
	B	5	5	10	10	15	20	20	10	15
	C	0	0	0	0	0	0	0	0	5
Back	A	10	10	0	0	0	90	70	90	95
	B	90	90	95	90	80	10	30	10	5
	C	0	0	5	10	20	0	0	0	0
Legs and wings	A	0	0	0	90	90	90	95	90	90
	B	20	80	50	10	10	10	5	10	10
	C	80	20	50	0	0	0	0	0	0
2.Fleshing	A	70	70	70	95	95	90	90	95	95
	B	30	30	30	5	5	10	10	5	5
	C	0	0	0	0	0	0	0	0	0
3.Fat covering	A	70	30	70	90	90	90	95	95	85
	B	30	70	30	10	10	10	5	5	15
	C	0	0	0	0	0	0	0	0	0
4.Pin feathers:										
Nonprotruding pins and hair	A	70	75	80	75	75	85	70	75	80
	B	15	20	20	10	15	15	10	20	15
	C	15	5	0	15	10	0	20	5	5

continued...

Table 9 (continued)...

1	2	3	4	5	6	7	8	9	10	11
Protruding pins	A	15	25	35	5	10	15	10	5	5
	B	30	25	20	15	20	30	75	85	90
	C	55	50	45	80	70	55	15	10	5
5. Cuts, tears, missing skin	A	0	0	0	20	50	40	20	35	45
	B	20	10	5	70	15	10	15	25	30
	C	80	90	95	10	35	50	65	40	25
6. Discolourations	A	0	0	0	40	70	50	40	40	70
	B	10	20	30	60	30	50	50	60	20
	C	90	80	70	0	0	0	10	0	10
7. Disjointed bones	A	90	90	95	95	80	100	100	100	90
	B	10	10	5	5	20	0	0	0	10
	C	0	0	0	0	0	0	0	0	0
8. Broken bones	A	100	90	100	100	100	100	100	100	100
	B	0	10	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0
9. Missing parts	A	100	100	100	100	100	100	100	100	100
	B	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0

Table 10. Effect of scalding techniques on grading defects of ready-to-cook chicken adult and broiler age groups (in percentage of grade).

Age groups/ characters	Grade	77°C/60 sec	77°C/90 sec	77°C/120 sec	60°C/60 sec	60°C/90 sec	60°C/120 sec	53°C/60 sec	53°C/90 sec	53°C/. sec
Chicken (Adults)										
Non-protruding pins and hair	A	90	30	40	0	0	0	0	0	0
	B	10	70	60	20	90	80	10	0	0
	C	0	0	0	80	10	20	90	100	100
Protruding pins	A	10	70	70	10	0	0	0	0	0
	B	60	30	30	70	50	60	10	20	30
	C	30	0	0	20	50	40	90	80	70
Cuts,tears and missing skin	A	0	5	5	60	40	0	40	45	55
	B	40	30	25	30	20	15	10	15	20
	C	60	65	70	10	40	85	50	40	25
Chicken (Broilers)										
Non-protruding pins and hair	A	70	75	80	75	75	85	70	75	80
	B	15	20	20	10	15	15	10	20	15
	C	15	5	0	15	10	0	20	5	5
Protruding pins	A	15	25	35	5	10	15	10	5	5
	B	30	25	20	15	20	30	75	85	90
	C	55	50	45	80	70	55	15	10	5
Cuts,tears and missing skin	A	0	0	0	20	50	40	20	35	45
	B	20	10	5	70	15	10	15	25	30
	C	80	90	95	10	35	50	65	40	25

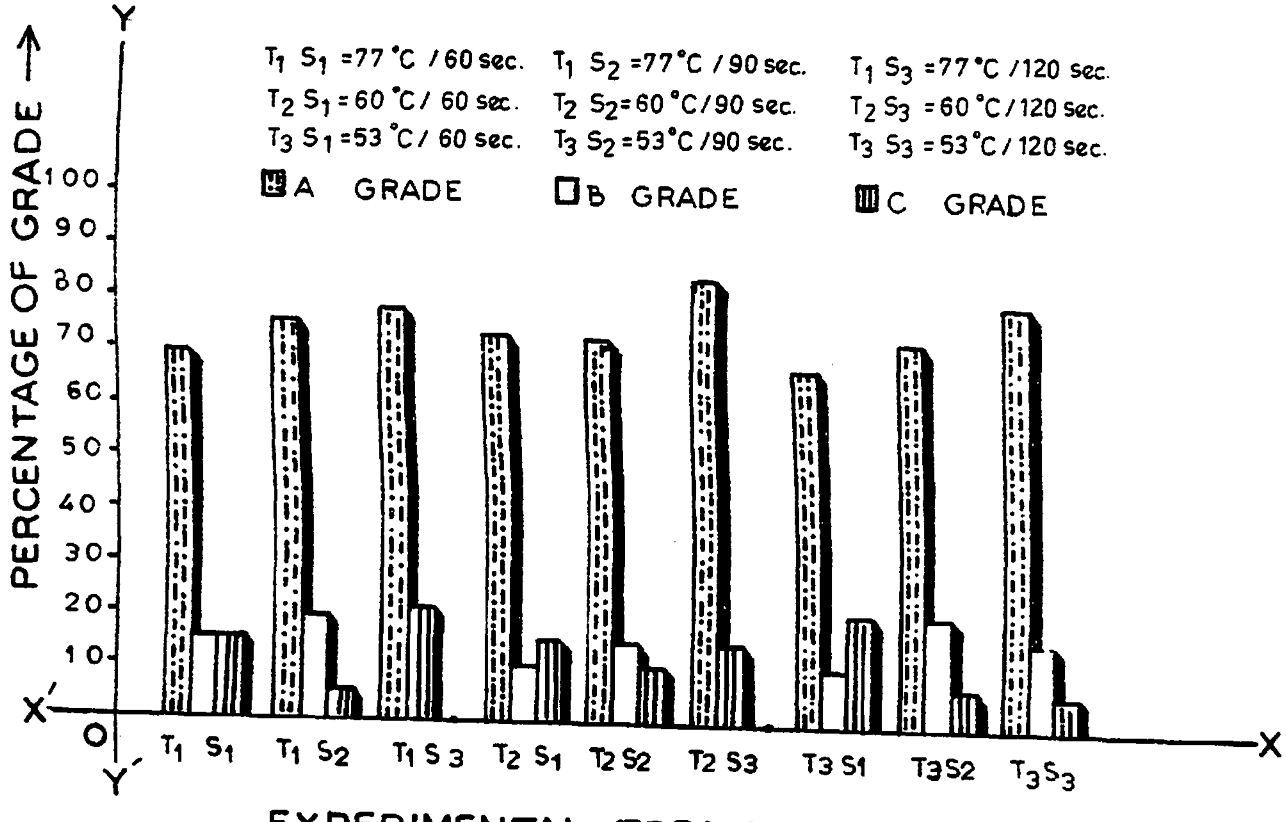


FIG-10. GRADING DEFECTS IN CHICKEN BROILER AGE GROUP: NON-PROTRUDING PINS & HAIR.

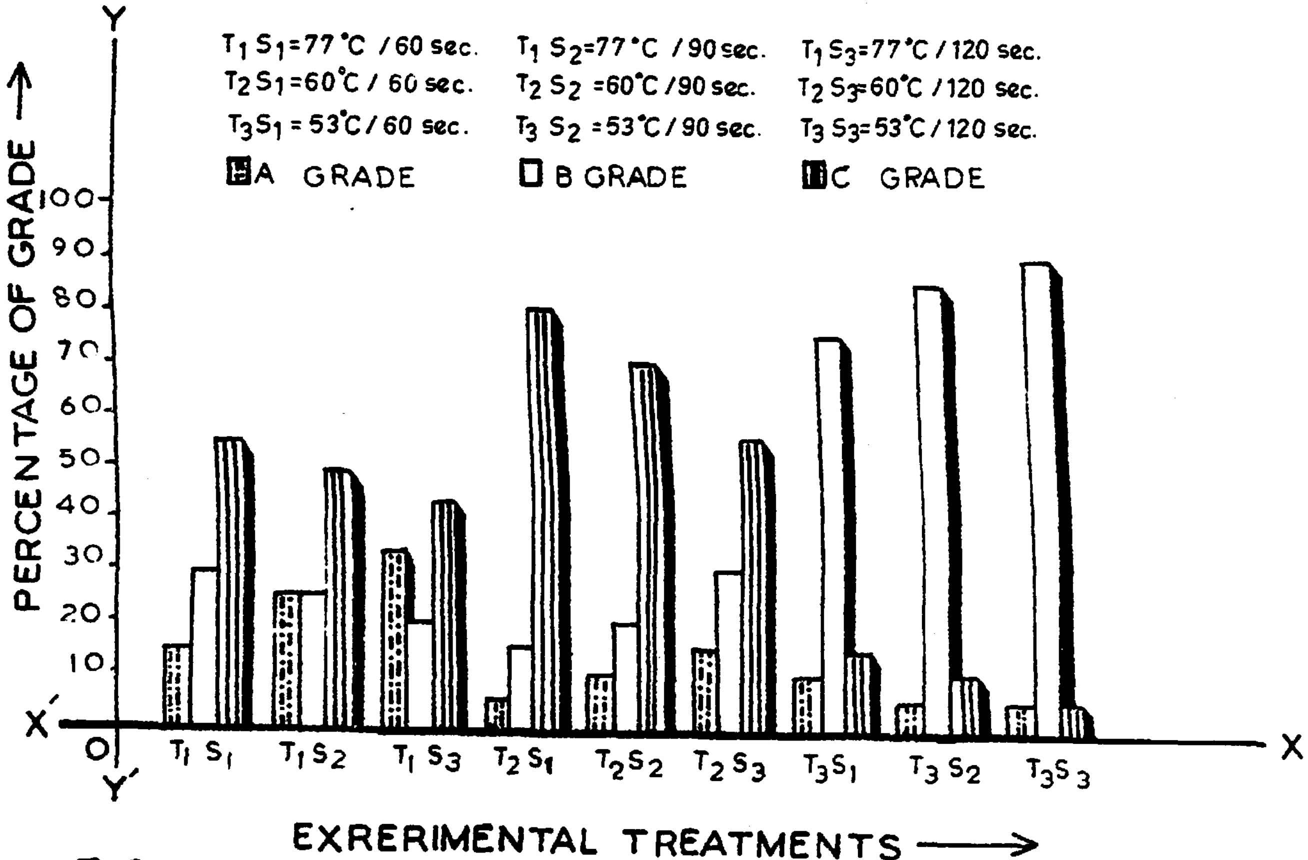


FIG-11. GRADING DEFECTS IN CHICKEN BROILER AGE GROUP: PROTRUDING PINS.

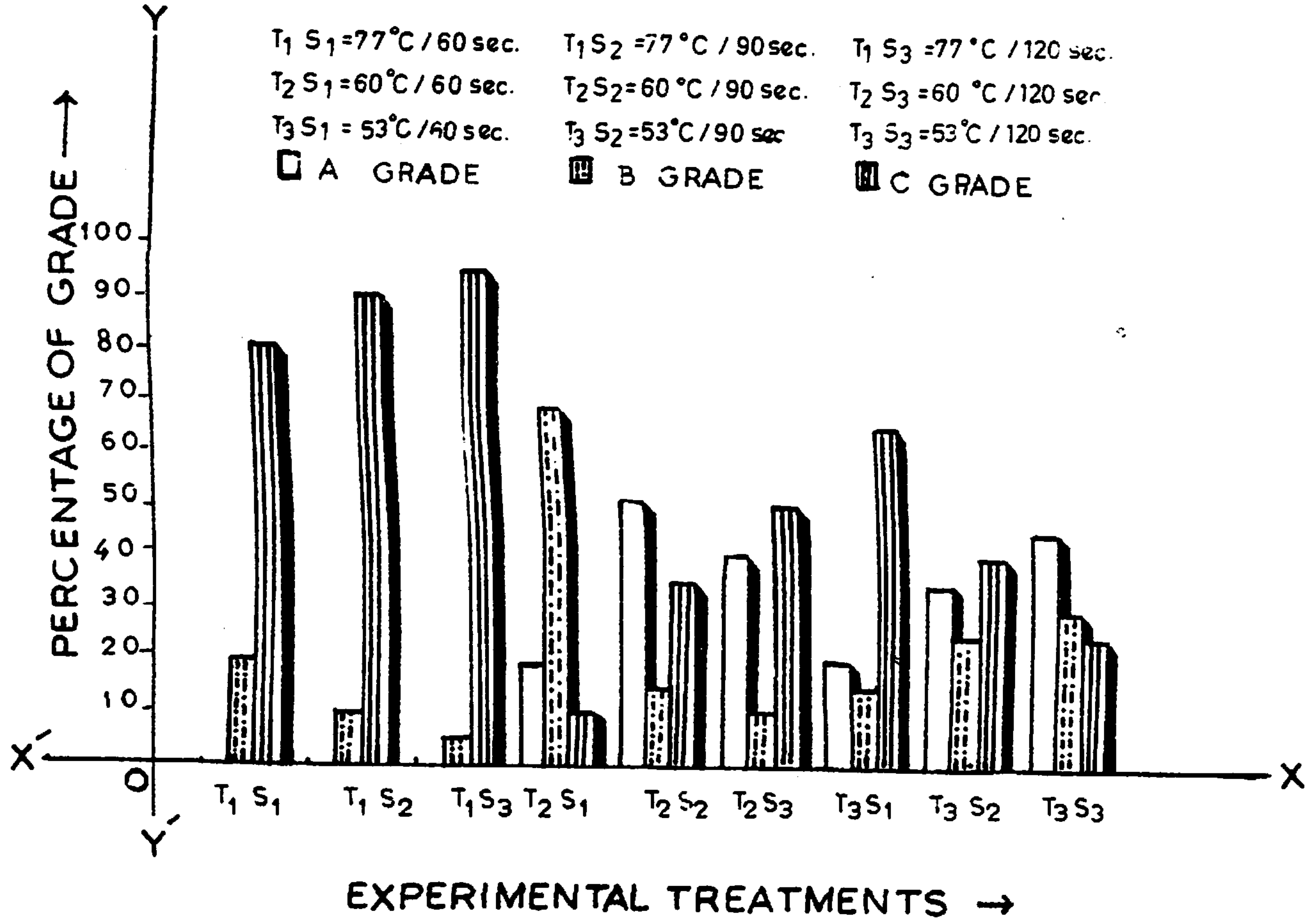


FIG-12 GRADING DEFECTS IN CHICKEN BROILER AGE GROUP: CUTS, TEARS & MISSING SKIN.

scalding temperatures (Pearce and Lavers, 1949; Knapp and Newell, 1961 and Klose et al., 1961). As regards cuts, tears and missing skin, the maximum defects were found in hard-scalding treatments. Semi-scalding treatments had relatively better results than subscalding treatments. While considering treatments within semi-scalding temperature, 53°C/120 sec. batch was found to have the least grading defects. Many observers also have given their conclusion in favour of semi-scalding technique for broilers. Parnell et al. (1950) reported that all the fryers scalded at 126°F were classed as grade A,while those scalded at 145°F were all grade C, because of numerous skin abrasions. Baker (1954), Heath (1972, 1973) and Heath and Thomas (1973, 1974) also have concluded that higher scalding temperature significantly decreased skin colour. Gupta et al. (1978) also reported adverse effect of higher scalding temperature and presence of tears on the skin surface of birds which is an important grading defect.

3. Effect of scalding on the bacteriological condition of dressed poultry

(a) Chicken adult age group :

The initial microbial load before storage and the final microbial load after 3 months of storage in deep freeze at -10°C were studied. The results (Table 11) showed that total plate count which was initially in the range of 9.5×10^4 to 77.166×10^4 reached 11.0×10^4 to 101×10^4 at the end of storage. While observing initial load within different treatments, the lowest count was for 53°C/60 sec. and the highest count for 77°C/120 sec. but for final microbial load, 60°C/60 sec. gave the lowest count, whereas the 77°C/120 sec. showed the highest count. This may be due to lower rate of microbial multiplication in case of 60°C/60 sec. treatment. The highest count in 77°C/120 sec. may be due to excessive abrasion of the skin tissue. The estimation of microbial load (both initial and final) in the present study was in agreement with resu- lts shown by May (1969) and Panda (1971). They have repor- ted that the number of microorganisms on the skin surface of warm eviscerated chicken carcasses varied from 10^2 to 16.8×10^7/sq.cm. and 2.5×10^5 to 5.4×10^6/sq.cm. respec- tively. The variations in the number of microorganisms in the present study can be explained based on the reasons put forward by Panda (1975), such as (i) scalding tempera- ture, (ii) initial low counts in live birds and (iii)dilu- tion effects of fresh scald water.

Table 11. Keeping quality studies for chicken adult age group.
Number of organisms/sq. cm. of skin surface.

Experimental treatments	Total plate count		Coliform count		Streptococcus faecalis		Total mould count	
	Initial load	Final load	Initial load	Final load	Count initial load	Final load	Initial load	Final load
77°C/60 sec.	$16.16 \pm 3.507 \times 10^4$	$19.0 \pm 3.256 \times 10^4$	$11.0 \pm 0.931 \times 10^2$	$13.333 \pm 1.202 \times 10^2$	$23.166 \pm 4.651 \times 10^3$	$27.00 \pm 5.404 \times 10^3$	$1.666 \pm 0.557 \times 10^4$	$2.5 \pm 0.67 \times 10^4$
77°C/90 sec.	$19.83 \pm 2.937 \times 10^4$	$26.0 \pm 3.503 \times 10^4$	$8.166 \pm 1.424 \times 10^2$	$9.333 \pm 1.282 \times 10^2$	$14.166 \pm 1.424 \times 10^3$	$15.666 \pm 1.282 \times 10^3$	$0.666 \pm 0.21 \times 10^4$	1.333 ± 0.333 X10
77°C/120 sec.	$71.166 \pm 6.751 \times 10^4$	$101.0 \pm 15.406 \times 10^4$	$23.0 \pm 10.346 \times 10^2$	$34.833 \pm 14.887 \times 10^2$	$11.666 \pm 1.382 \times 10^3$	$13.166 \pm 2.242 \times 10^3$	$0.5 \pm 0.223 \times 10^4$	1.666 ± 0.333 X10
60°C/60 sec.	$10.333 \pm 1.909 \times 10^4$	$11.0 \pm 2.366 \times 10^4$	$19.666 \pm 7.598 \times 10^2$	$20.033 \pm 5.493 \times 10^2$	$7.166 \pm 0.703 \times 10^3$	$7.666 \pm 0.802 \times 10^3$	$0.8 \pm 0.365 \times 10^4$	1.0 ± 0.516 X10
60°C/90 sec.	$45.15 \pm 23.316 \times 10^4$	$50.0 \pm 25.399 \times 10^4$	$7.166 \pm 1.922 \times 10^2$	$7.833 \pm 1.47 \times 10^2$	$5.666 \pm 1.498 \times 10^3$	$8.5 \pm 2.553 \times 10^3$	$0.5 \pm 0.341 \times 10^4$	1.166 ± 0.477 X10
60°C/120 sec.	$21.833 \pm 6.716 \times 10^4$	$26.166 \pm 6.317 \times 10^4$	$9.0 \pm 1.88 \times 10^2$	$9.5 \pm 1.628 \times 10^2$	$18.166 \pm 3.177 \times 10^3$	$19.333 \pm 3.694 \times 10^3$	$0.833 \pm 0.307 \times 10^4$	1.333 ± 0.421 X10
53°C/60 sec.	$9.5 \pm 1.784 \times 10^4$	$11.66 \pm 2.231 \times 10^4$	$31.833 \pm 5.565 \times 10^2$	$34.333 \pm 5.554 \times 10^2$	$3.666 \pm 0.666 \times 10^3$	$5.0 \pm 0.577 \times 10^3$	$1.5 \pm 0.562 \times 10^4$	2.5 ± 0.428 X10
53°C/90 sec.	$42.166 \pm 12.155 \times 10^4$	$48.0 \pm 13.135 \times 10^4$	$11.666 \pm 3.052 \times 10^2$	$12.5 \pm 3.491 \times 10^2$	$6.5 \pm 0.562 \times 10^3$	$9.0 \pm 0.816 \times 10^3$	$0.666 \pm 0.21 \times 10^4$	1.666 ± 0.333 X10
53°C/120 sec.	$13.333 \pm 3.499 \times 10^4$	$16.333 \pm 4.537 \times 10^4$	$17.333 \pm 6.894 \times 10^2$	$23.0 \pm 8.447 \times 10^2$	$6.5 \pm 0.718 \times 10^3$	$7.16 \pm 0.945 \times 10^3$	$1.033 \pm 0.494 \times 10^4$	1.666 ± 0.666 X10

Coliform counts showed a variation from 7.166×10^2 to 31.833×10^2 per sq.cm. on skin surface in case of initial load, whereas in case of final load it was from 7.833×10^2 to 34.833×10^2. This range was higher than that reported by Panda (1971). While considering the initial count, the highest count was seen in 53°C/60 sec.batch, whereas the lowest count was for 60°C/90 sec. This may be due to heat sensitivity of coliform organisms above 60°C, as described by Notermans _et al_. (1977). It was found that hard scalding treatments were attributed with relatively higher coliform counts than sub-scald treatments. The possible reason may be that skin acts as a bacterial barrier and hard scalding caused numerous abraisons (Mundt _et al_., 1954; Arafa _et al_., 1978; McCarthy _et al_., 1962). Also it might be due to rapid increase in the bacterial count in the scald water (Pelletan, 1972). Considering the final load, it is clear that the rate of multiplication for 60°C/60 sec. treatment was lowest, which can be recommended for the scalding of chicken belonging to adult age group.

The Streptococcus faecalis ranged from 3.666×10^3 to 23.166×10^3 in case of initial load and from 5.0×10^3 to 27.0×10^3 in case of final load (Table 11). It was found that high scalding temperature and long scalding time did not reduce the initial load of Streptococcus faecalis. This may be due to heat resistance of these organisms (Leon Crespo et al., 1977). The result in the present study showed higher value than the results showed by Panda (1971). It may be due to insufficient washing of the finished product (Keel and Parmelee, 1968; Fromm, 1959; Galton et al., 1955 and Salzer et al., 1967) due to the manual indigenous processing technique adopted for the study. However, in considering the final load, it was evident that the rate of multiplication of the organisms during storage was lowest in case of 60°C/60 sec. batch which again goes in favour of the said temperature-time schedule for scalding of adult chickens.

Total mould count due to different scalding techniques in adult chickens varied from 0.5×10^4 to 1.666×10^4 in case of initial load and from 1.0×10^4 to 2.5×10^4 in case of final load. This result was in agreement with the results shown by Panda (1971). The relatively higher counts in case of semi-scalding treatments as compared to sub-scalding treatments can be justified by the low scalding temperature and more pin feathers left over the carcasses which might be the source of contamination, also higher counts in hard scalding treatments may be justified due to skin abraisons.

(b) Duck adult age group :

The estimation of total plate count, coliform count, Streptococcus faecalis count and total mould count in case of duck adult age group is shown in Table 12. It is evident from the results that initial total plate count ranged from 14.5×10^4 to 76.166×10^4 and from 16.0×10^4 to 106.333×10^4 at the final stage. The initial load was lowest for $53^oC/60$ sec. treatment batch and highest for $77^oC/120$ sec.treatment batch. But, while considering final load, it was lowest for $60^oC/120$ sec. and highest for $77^oC/120$ sec.treatment batch. On the other hand, the increase in microbial number after storage was lowest in case of $60^oC/120$ sec. Hence, this scalding treatment is desirable for ducks belonging to adult age group.

In different scalding treatments of ducks,coliform counts varied from 12.166×10^2 to 36.833×10^2 in case of initial load, whereas from 12.833×10^2 to 39.666×10^2 in case of final load. The highest count was found in $53^oC/60$ sec.treatment and lowest count in $60^oC/120$ sec. treatment. The possible reason for this may be due to heat sensitivity

Table 12. Keeping quality studies for duck adult age group. Number of organisms/sq. cm. of skin surface.

Experimental treatments	Total plate count		Coliform count		Streptococcus faecalis count		Total mould count	
	Initial load	Final load	Initial load	Final load	Initial load	Final load	Initial load	Final load
77°C/60 sec.	20.833 ±4.625 X10^{4}	23.833 ±4.325 X10^{4}	15.666 ±1.405 X10^{2}	18.0 ±1.702 X10^{2}	28.866 ±4.751 X10^{3}	32.5 ±5.49 X10^{3}	2.461 ±0.647 X10^{4}	3.35 ±0.759 X10^{4}
77°C/90 sec.	25.0 ±3.537 X10^{4}	30.833 ±3.936 X10^{4}	12.666 ±1.967 X10^{2}	14.333 ±1.782 X10^{2}	14.216 ±1.534 X10^{3}	20.49 ±1.303 X10^{3}	1.391 ±0.363 X10^{4}	2.15 ±0.555 X10^{4}
77°C/120 sec.	76.166 ±7.571 X10^{4}	106.333 ±16.06 X10^{4}	24.666 ±8.204 X10^{2}	31.333 ±10.006 X10^{2}	16.75 ±1.523 X10^{3}	18.69 ±2.23 X10^{3}	1.196 ±0.335 X10^{4}	1.433 ±0.412 X10^{4}
60°C/60 sec.	31.166 ±8.159 X10^{4}	33.5 ±8.615 X10^{4}	28.0 ±11.346 X10^{2}	39.666 ±15.38 X10^{2}	22.413 ±3.612 X10^{3}	25.05 ±4.09 X10^{3}	1.205 ±0.223 X10^{4}	1.806 ±0.609 X10^{4}
60°C/90 sec.	50.5 X10^{4} ±26.411	55.5 X10^{4} ±28.47	14.2 X10^{2} ±0.506	15.0 X10^{2} ±2.223	9.486 ±1.599 X10^{3}	11.5 ±2.536 X10^{3}	1.037 ±0.463 X10^{4}	1.659 ±0.579 X10^{4}
60°C/120 sec.	15.333 ±3.025 X10^{4}	16.0 ±2.933 X10^{4}	12.166 ±2.467 X10^{2}	12.833 ±1.989 X10^{2}	11.07 ±0.846 X10^{3}	11.53 ±0.95 X10^{3}	1.59 ±0.437 X10^{4}	1.65 ±0.686 X10^{4}
53°C/60 sec.	14.5 X10^{4} ±2.213	16.833 X10^{4} ±2.712	36.833 X10^{2} ±6.207	39.666 X10^{2} ±6.171	6.022 X10^{3} ±0.833	8.01 X10^{3} ±0.767	2.07 X10^{4} ±0.737	2.16 X 10^{4} ±0.645
53°C/90 sec.	48.0 ±13.345 X10^{4}	51.0 ±13.352 X10^{4}	14.333 ± 3.59 X10^{2}	17.5 ±3.99 X10^{2}	9.23 ±0.703 X10^{3}	11.766 ±1.041 X10^{3}	1.527 ±0.456 X10^{4}	1.593 ±0.516 X10^{4}
53°C/120 sec.	14.5 ±3.863 X10^{4}	21.333 ± 4.836 X10^{4}	22.0 ± 6.445 X10^{2}	28.0 ±8.974 X10^{2}	9.46 ±0.924 X10^{3}	10.203 ±1.14 X10^{3}	1.596 ±0.565 X10^{4}	1.99 ±0.793 X10^{4}

of coliforms at or more than 60°C. While comparing between initial and final load, the growth of the organisms was least in case of 60°C/120 sec.treatment, which can be recommended for the scalding of adult ducks.

In relation to Streptococcus faecalis count,it ranged from 6.022×10^3 to 28.866×10^3 for initial count and from 8.01×10^3 to 32.5×10^3 for final load. The higher counts in hard scalding treatments may be caused by skin abraisons and lower counts in semi-scalding due to intact skin. When comparison is made among counts of initial load, with final load, to know the increase in growth of the organisms, 60°C/120 sec. gave the best result.

Total mould count was observed to vary from 1.037×10^4 to 2.461×10^4 in case of initial load and from 1.433×10^4 to 3.35×10^4 in case of final load. The higher counts were related to high scalding temperature and skin abraisons and higher counts in semi-scalding treatments might be due to more pinfeathers over the carcasses. By comparing the counts of initial load with final load, the increase in numbers of moulds was lowest in case of 60°C/120 sec. treatment which can be taken as least for adult ducks.

(c) Chicken broiler age group :

After conducting different scalding treatments in broiler chickens for studying keeping quality (Table 13), it was observed that initial total plate count ranged from 8.333×10^4 to 167.5×10^4 and final from 9.5×10^4 to 1.5×10^9 per sq.cm. of skin surface. In semi-scalding treatments, both initial and final load was lowest and growth of number of organisms was also lowest during storage of 3 months. In subscalding treatments, the microbial loads were higher and in case of hard scalding treatments, the count was highest. The adverse effect due to high scalding temperature and long scalding time is compatible with the results found out by the workers viz., Arafa et al. (1978), McCarthy et al. (1962). The possible reason may be protective action of the intact skin (Mundt et al., 1954). Broiler carcasses treated with hard scalding methods had higher initial and final count which was reported to vary from 1.0×10^9 to 1.5×10^9. That is why, off-odour and slime was developed deteriorating the meat quality turning it unacceptable. This effect has already been confirmed by other workers viz. May et al. (1962), Lockhead and Landerkin (1939), Ayres et al. (1950), Elliot and Michener (1961), Panda (1970) and Essary et al. (1958). While

Table 13. Keeping quality studies for chicken broiler age group. Number of organisms/sq. cm. of skin surface.

Experimental treatments	Total plate count		Coliform count		Streptococcus faecalis count		Total mould count	
	Initial load	Final load	Initial load	Final load	Initial load	Final load	Initial load	Final load
77°C/60 sec.	135.32 ±19.731 X10^4	1.0 X10^9	9.303 ±0.791 X10^2	29.561 ±10.27 X10^2	9.666 ±4.505 X10^3	12.866 ±1.701 X10^3	0.876 ±0.567 X10^4	1.77 ±0.733 X10^4
77°C/90 sec.	146.7 ±23.56 X10^4	1.2 X10^9	12.181 ±3.133 X10^2	35.973 ±12.011 X10^2	12.333 ±0.577 X10^3	19.0 ±3.256 X10^3	0.544 ±0.178 X10^4	0.933 ±0.253 X10^4
77°C/120 sec.	167.5 ±40.39 X10^4	1.5 X10^9	13.833 ±4.676 X10^2	42.086 ±7.93 X10^2	10.333 ±1.283 X10^3	16.406 ±3.503 X10^3	0.563 ±0.213 X10^4	0.839 ±0.239 X10^4
60°C/60 sec.	8.50 ± 1.648 X10^4	9.50 ±1.607 X10^4	17.166 ±6.578 X10^2	22.00 ±5.347 X10^2	6.166 ±0.762 X10^3	7.166 ±0.72 X10^3	0.80 ±0.451 X10^4	1.05 ±0.212 X10^4
60°C/90 sec.	53.166 ±22.526 X10^4	46.666 ±24.358 X10^4	6.166 ±1.933 X10^2	7.966 ±1.989 X10^2	4.50 ±0.998 X10^3	7.50 ±2.435 X10^3	0.465 ±0.689 X10^4	0.70 ±0.986 X10^4
60°C/120 sec.	22.333 ± 5.909 X10^4	30.666 ±6.012 X10^4	6.50 ±1.202 X10^2	7.66 ±0.993 X10^2	15.333 ±3.666 X10^3	16.833 ±3.648 X10^3	0.411 ±0.275 X10^4	0.636 ±0.312 X10^4
53°C/60 sec.	8.333 ± 1.686 X10^4	9.833 ±1.701 X10^4	28.666 ±4.443 X10^2	30.50 ±6.555 X10^2	4.333 ±0.282 X10^3	5.33 ±0.767 X10^3	0.97 ±0.248 X10^4	1.215 ±0.324 X10^4
53°C/90 sec.	37.50 ±12.026 X10^4	43.00 ±12.886 X10^4	18.16 ±2.757 X10^2	19.50 ±3.33 X10^2	5.166 ±0.675 X10^3	7.333 ±0.833 X10^3	0.453 ±0.203 X10^4	0.635 ±0.221 X10^4
53°C/120	9.833 ± 2.272 X10^4	10.666 ±4.362 X10^4	13.333 ±5.643 X10^2	14.166 ±7.448 X10^2	5.333 ±0.633 X10^3	5.833 ±1.011 X10^3	1.005 ±0.323 X10^4	1.113 ±0.444 X10^4

comparing different scalding treatments for increase in the number of organism during storage period, it was found that $53^{o}C/120$ sec.gave the best result.

The coliform counts varied from 6.166×10^2 to 28.666×10^2 in case of initial load and from 7.66×10^2 to 42.086×10^2 in case of final load. The highest count was seen in semi-scalding treatments. The reason might be due to low scalding temperature. Hard scalding treatments had higher counts than subscalding treatments. This may be as a result of breakdown of intact skin. But, after comparing the increase in the number of organisms among different treatment groups, it was concluded that $53^{o}C/120$ sec.treatment batch had the best result.

Streptococcus faecalis count of the carcasses ranged from 4.333×10^3 to 15.333×10^3 in case of initial microbial load, whereas, it was from 5.33×10^3 to 19.0×10^3 at the end of final microbial estimation. The counts were more as the scalding temperature increased. The possible reasons might be the heat resistant strains of Streptococcus faecalis gaining access to the bruised skin and creating a favourable internal milleu. In this context, Leon Crespo _et al._ (1977) also have shown the heat resistance property of Streptococcous faecalis. But during storage,

$53^oC/120$ sec.gave the best result.

Total mould count over broiler carcasses was found to be in the range of 0.411×10^4 to 1.005×10^4 in case of initial load and from 0.635×10^4 to 1.77×10^4 in case of final load. The highest count was found in semi-scalding treatment. But sub-scalding treatments had relatively lower counts than hard scalding treatments. The count range estimated was in agreement with that of Panda (1971). However, during storage study, the increase in the number of organisms was lowest for $53^oC/120$ sec.treatment batch.

4. Effect of scalding on organoleptic properties of poultry meat

(a) Chicken adult age group :

The organoleptic properties of leg muscle of adult chicken influenced by different scalding techniques were studied by means of a 9-point haedonic scale. The results are shown in Table 14. The scores for appearance, flavour, tenderness, juiceness and acceptability ranged respectively from 6.166 ± 0.319 to 6.975 ± 0.141, 5.43 ± 0.314 to 6.55 ± 0.17, 5.395 ± 0.176 to 6.7 ± 0.167, 5.523 ± 0.227 to 6.55 ± 0.164 and 5.777 ± 0.347 to 7.033 ± 0.162.

Table 14. Organoleptic evaluation of chicken adult age group: Leg muscle. (Pooled mean ± S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	6.408[a] ±0.192	5.808[a] ±0.23	5.8[a] ±0.255	5.691[a] ±0.266	5.925[a] ±0.265
77°C/90 sec.	6.166[a] ±0.319	5.43[a] ±0.314	5.986[a] ±0.352	5.805[a] ±0.316	5.777[a] ±0.347
77°C/120 sec.	6.525[a] ±0.144	6.241[a] ±0.227	6.066[a] ±0.172	5.783[a] ±0.228	6.275[a] ±0.194
60°C/60 sec.	6.975[b] ±0.141	6.55[b] ±0.17	6.7[b] ±0.167	6.55[b] ±0.164	7.033[b] ±0.162
60°C/90 sec.	6.733[b] ±0.153	6.533[b] ±0.195	6.46[b] ±0.196	6.183[a] ±0.208	6.755[b] ±0.199
60°C/120 sec.	6.875[b] ±0.146	5.95[a] ±0.219	6.425[b] ±0.168	6.358[b] ±0.141	6.516[b] ±0.19
53°C/60 sec.	6.65[b] ±0.124	6.375[b] ±0.154	5.858[a] ±0.202	6.308[b] ±0.147	6.541[b] ±0.162
53°C/90 sec.	6.758[b] ±0.169	5.983[a] ±0.191	5.395[a] ±0.176	5.958[a] ±0.171	6.171[a] ±0.181
53°C/120 sec.	6.371[a] ±0.156	6.021[a] ±0.138	5.518[a] ±0.218	5.523[a] ±0.227	5.936[a] ±0.183

Figures with different superscripts differ significantly at $P < 0.05$.

In case of appearance, flavour and acceptability, the lowest score was obtained for hard scalding treatment (77°C/90 sec.) and highest score was obtained for subscalding treatment (60°C/60 sec.) which were also statistically significant. But in case of tenderness and juiceness properties, the highest score was also obtained for the treatment 60°C/60 sec. whereas lower scores were found in both semi-and hard-scalding treatments. Above all,the subscalding treatment (60°C/60 sec.) was found to be best among all.

While considering the organoleptic properties of breast muscle (Table 15), the mean scores for appearance, flavour, tenderness, juiceness and acceptability ranged respectively from 6.241 ± 0.175 to 7.133 ± 0.158, 5.111 ± 0.401 to 6.775 ± 0.172, 5.583 ± 0.424 to 7.108 ± 0.137, 5.027 ± 0.423 to 6.666 ± 0.175, and 5.555 ± 0.385 to 7.266 ± 0.156. In all cases of organoleptic properties, the highest score obtained was fallen in the same sub-scalding temperature but with different time duration and the lowest score was in hard scalding treatment (77°C/90 sec.) except appearance score, which gave lowest score for 53°C/120 sec. The abuse of hard scalding treatments for the organoleptic properties has been well recognised in the

Table 15. Organoleptic evaluation of chicken adult age group: Breast muscle. (Pooled mean ± S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	6.5[a] ±0.173	6.233[a] ±0.229	6.225[a] ±0.228	5.991[a] ±0.238	6.108[a] ±0.23
77°C/90 sec.	6.638[a] ±0.303	5.111[c] ±0.401	5.583[c] ±0.424	5.027[c] ±0.423	5.555[a] ±0.385
77°C/120 sec.	6.341[a] ±0.302	6.175[a] ±0.265	6.4[a] ±0.231	6.091[a] ±0.255	6.05[a] ±0.256
60°C/60 sec.	7.133[a] ±0.158	6.775[a] ±0.172	7.075[b] ±0.113	6.525[a] ±0.11	7.225[c] ±0.124
60°C/90 sec.	7.133[a] ±0.164	6.733[b] ±0.188	7.108[b] ±0.137	6.566[a] ±0.153	7.266[c] ±0.156
60°C/120 sec.	6.991[a] ±0.206	6.741[a] ±0.26	7.025[b] ±0.163	6.666[b] ±0.175	7.211[c] ±0.194
53°C/60 sec.	7.133[a] ±0.177	6.4[a] ±0.216	6.616[a] ±0.149	6.525[a] ±0.131	6.983[b] ±0.184
53°C/90 sec.	7.133[a] ±0.173	6.241[a] ±0.231	6.611[a] ±0.096	6.205[a] ±0.105	6.743[b] ±0.153
53°C/120 sec.	6.241[a] ±0.175	6.153[a] ±0.145	6.388[a] ±0.141	6.651[b] ±0.513	6.378[b] ±0.127

Figures with different superscripts differ significantly at $P \angle 0.05$.

reports shown by Klose (1960), Klose *et al.* (1959), Shannon *et al.* (1957), Pool *et al.* (1959), Wise and Stadelman (1961), Singh and Mohapatra (1979), Johnson (1971), and Pandey and Singh (1979). Statistical analysis also indicated better organoleptic characters of the samples obtained from subscalding treatments.

These results indicate that the most of the organoleptic properties were in the subscalding temperature 60°C/60 sec.for leg and breast muscle when considered in total. Therefore, as regards organoleptic properties this may be taken as one of the best time/temperature combination.

(b) Duck adult age group :

Experimental studies for organoleptic properties of meat obtained from duck adult age group following different treatments are shown in Table 16 and 17. The mean scores in case of leg muscle (Table 16) for appearance, flavour, tenderness, juiceness and acceptability ranged respectively from 5.75 $\pm$ 0.562 to 7.15 $\pm$ 0.208, 5.725$\pm$0.563 to 7.15 $\pm$ 0.264, 5.575 $\pm$ 0.607 to 7.15 $\pm$ 0.399, 5.75$\pm$0.56 to 6.925 $\pm$ 0.286, and 5.675 $\pm$ 0.512 to 7.25 $\pm$ 0.33. In all these cases, hard scalding treatments had lowest score and

Table 16. Organoleptic evaluation of duck adult age group: Leg muscle. (Pooled mean $\pm$ S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	6.475^{b} ± 0.358	6.35^{ac} ± 0.387	6.35^{ac} ± 0.355	6.29^{a} ± 0.363	6.375^{a} ± 0.351
77°C/90 sec.	6.335^{bc} ± 0.427	6.95^{b} ± 0.376	6.55^{ac} ± 0.493	6.31^{a} ± 0.491	6.675^{a} ± 0.462
77°C/120 sec.	5.875^{a} ± 0.599	5.725^{a} ± 0.563	5.575^{a} ± 0.607	5.75^{a} ± 0.56	5.675^{a} ± 0.512
60°C/60 sec.	7.15^{bd} ± 0.208	7.15^{b} ± 0.264	7.15^{bc} ± 0.399	6.85^{b} ± 0.322	7.25^{b} ± 0.333
60°C/90 sec.	6.825^{b} ± 0.227	6.875^{b} ± 0.315	6.85^{ac} ± 0.281	6.925^{bc} ± 0.286	6.9^{b} ± 0.304
60°C/120 sec.	6.35^{bc} ± 0.426	6.325^{ac} ± 0.921	6.05^{ac} ± 0.296	6.3^{a} ± 0.196	6.35^{a} ± 0.217
53°C/60 sec.	5.75^{a} ± 0.562	6.625^{b} ± 0.223	6.5^{ac} ± 0.334	6.2^{a} ± 0.279	6.5^{a} ± 0.309
53°C/90 sec.	6.225^{a} ± 0.511	6.275^{ac} ± 0.388	6.05^{ac} ± 0.512	6.025^{a} ± 0.47	6.15^{a} ± 0.51
53°C/120 sec.	6.1^{a} ± 0.44	6.4^{ac} ± 0.442	6.675^{ac} ± 0.44	6.5^{ab} ± 0.368	6.6^{a} ± 0.369

Figures with different superscripts differ significantly at $P < 0.05$.

the subscalding treatments had the highest score.

Similarly for breast muscle (Table 17), the mean scores for the properties, viz. appearance, flavour, tenderness, juiceness and acceptability ranged respectively from 5.3 $\pm$ 0.4 to 6.933 $\pm$0.197, 5.833 $\pm$ 0.329 to 7.333 $\pm$ 0.09, 5.816 $\pm$ 0.234 to 7.216 $\pm$ 0.273, 5.683 $\pm$ 0.233 to 6.983 $\pm$ 0.165, and 5.7 $\pm$ 0.306 to 6.95 $\pm$ 0.183. The highest scores was found in the same subscalding temperature but with different time duration, and the lowest score was obtained at 53°C/60 sec.for appearance and flavour, at 77°C/60 sec.for tenderness score and at 60°C/120 sec. for juiceness and acceptability. Gey and Pingel (1977) while studying scalding effect on duck and goose meat concluded that scalding temperature of 135°F was preferred to 144°F for quality indicators viz. grilling loss, juice retention, consistency and meat colour.

Based on the findings and statistical analysis of the same, it is clear that the organoleptic value of both breast and leg meat is better in the subscalding temperature with timings varying from 60 to 120 sec. However, much reliance cannot be given to these results of effect of scalding on organoleptic properties, as the semi-trained panel employed were new to the use of duck meat. More work

Table 17. Organoleptic evaluation of duck adult age group: Breast muscle. (Pooled ± S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	6.85^{bc} ±0.244	6.783^{b} ±0.284	5.816^{a} ±0.234	6.71^{b} ±0.264	6.95^{b} ±0.279
77°C/90 sec.	6.383^{b} ±0.339	6.716^{b} ±0.287	6.6^{b} ±0.337	6.516^{b} ±0.279	6.533^{b} ±0.323
77°C/120 sec.	5.433^{a} ±0.367	6.25^{a} ±0.34	6.6^{b} ±0.734	6.066^{a} ±0.323	5.9^{a} ±0.336
60°C/60 sec.	6.650^{bc} ±0.196	7.133^{cb} ±0.164	7.066^{b} ±0.197	6.75^{b} ±0.22	6.95^{b} ±0.206
60°C/90 sec.	6.933^{bd} ±0.197	7.333^{cb} ±0.09	7.0^{b} ±0.221	6.983^{b} ±0.165	6.95^{b} ±0.183
60°C/120 sec.	5.933^{b} ±0.348	6.866^{a} ±0.332	7.216^{b} ±0.273	5.683^{a} ±0.233	5.7^{a} ±0.306
53°C/60 sec.	5.3^{a} ±0.4	5.833^{a} ±0.329	5.933^{a} ±0.281	5.783^{a} ±0.245	5.816^{a} ±0.258
53°C/90 sec.	5.9^{b} ±0.384	6.2^{a} ±0.283	5.95^{a} ±0.361	5.816^{a} ±0.32	5.883^{a} ±0.322
53°C/120 sec.	6.65^{bc} ±0.271	6.466^{a} ±0.306	6.95^{b} ±0.283	6.466^{b} ±0.242	6.8^{b} ±0.277

Figures with different superscripts differ significantly at $P \angle 0.05$.

may be needed to come to a definite conclusion.

(c) Chicken broiler age group :

The haedonic scores of the organoleptic properties, viz. appearance, flavour, tenderness, juiceness and acceptability of leg meat from chicken broiler age group as influenced by different scalding techniques(Table 18) were within the range of 6.450 ± 0.153 to 8.887±0.086, 6.131 ± 0.206 to 7.680 ± 0.775, 6.205 ± 0.197 to 7.650 ± 0.118, 6.200 ± 0.155 to 7.358 ± 0.135 and 6.385 ± 0.2 to 8.12 ± 0.705, respectively. In all the cases, the lowest score was obtained in subscalding treatment and highest score was within the semiscalding treatments. While considering the same organoleptic properties in case of breast meat (Table 19) the scores for the appearance, flavour, tenderness, juiceness and acceptability were from 6.503 ± 0.126 to 8.566 ± 0.052, 6.275 ± 0.275 to 6.954 ± 0.199, 6.158 ± 0.135 to 8.661 ± 0.051, 6.368 ± 0.145 to 7.154 ± 0.164 and from 6.541 ± 0.202 to 8.225 ± 0.955, respectively. The highest score for all the eating quality factors was from semiscalding treatments whereas the lowest score was from the subscalding treatments except flavour score, that was lowest in 53^{o}C/120 sec. treatment. Both

Table 18. Organoleptic evaluation of chicken broiler age group: Leg muscle.
(Pooled mean $\pm$ S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
77°C/90 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
77°C/120 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
60°C/60 sec.	6.588^{a} ± 0.151	6.131^{a} ± 0.206	6.205^{a} ± 0.197	6.200^{a} ± 0.155	6.385^{a} ± 0.200
60°C/90 sec.	6.450^{a} ± 0.153	6.300^{a} ± 0.209	6.645^{a} ± 0.238	6.229^{a} ± 0.242	6.729^{a} ± 0.555
60°C/120 sec.	6.856^{b} ± 0.158	6.705^{a} ± 0.178	7.280^{b} ± 0.139	7.000^{b} ± 0.144	6.933^{a} ± 0.183
53°C/60 sec.	6.941^{b} ± 0.132	7.325^{b} ± 0.141	7.583^{bc} ± 0.158	7.358^{b} ± 0.135	8.120^{b} ± 0.705
53°C/90 sec.	8.887^{d} ± 0.086	7.132^{b} ± 0.151	7.650^{bc} ± 0.118	6.991^{b} ± 0.124	7.550^{ba} ± 0.127
53°C/120 sec.	8.117^{c} ± 0.302	7.680^{b} ± 0.775	7.221^{b} ± 0.142	6.591^{a} ± 0.200	6.800^{a} ± 0.220

N.D. = Not done due to that the meat was spoiled by hard scalding effect.

Figures with different superscripts differ significantly at $P < 0.05$.

Table 19. Organoleptic evaluation of chicken broiler age group: Breast muscle.
(Pooled mean ± S.E.)

Experimental treatments	Appearance	Flavour	Tenderness	Juiceness	Acceptability
77°C/60 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
77°C/90 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
77°C/120 sec.	N.D.	N.D.	N.D.	N.D.	N.D.
60°C/60 sec.	6.503^{a} ±0.126	6.638^{a} ±0.125	6.158^{a} ±0.135	6.400^{a} ±0.117	6.610^{a} ±0.119
60°C/90 sec.	6.758^{b} ±0.161	6.416^{a} ±0.184	6.604^{a} ±0.177	6.762^{b} ±0.362	6.541^{a} ±0.202
60°C/120 sec.	6.795^{b} ±0.166	6.760^{a} ±0.129	6.980^{a} ±0.117	6.368^{a} ±0.145	6.668^{a} ±0.147
53°C/60 sec.	6.579^{a} ±0.180	6.954^{b} ±0.199	7.537^{b} ±0.147	7.154^{cb} ±0.164	8.225^{b} ±0.955
53°C/90 sec.	8.566^{c} ±0.052	6.562^{a} ±0.163	6.900^{a} ±1.084	6.991^{b} ±0.124	6.933^{a} ±0.127
53°C/120 sec.	6.520^{a} ±0.319	6.275^{a} ±0.275	8.661^{bc} ±0.051	6.591^{a} ±0.200	8.025^{b} ±1.215

N.D. = Not done due to that the meat was spoiled by hard scalding effect.

Figures with different superscripts differ significantly at P ∠ 0.05.

leg meat and breast meat treated with hard scalding treatments after 3 months of storage showed the development of slime formation and off-odour due to high initial microbial load. So, these treatment groups were not studied for organoleptic evaluation. In the present study semi-scalding treatments were preferred to subscalding treatments. This work has also been supported by workers, viz. Lineweaver and Klose (1952), Graf and Stewart (1953), Baker (1955 a), Klose and Pool (1954) and Pool et al.(1954). All of them concluded that semiscalding treatment gave the normal appearance of the broiler carcasses and subscalding gave darkened appearance. The adverse effect of high scalding temperature and longer scalding time on tenderness and juiceness has already been described in case of adult chickens. The same is also true for broiler chickens. Pandey and Singh (1979) reported that scalding the birds above 140^{o}F (60^{o}C) for 2 min.gave it a "cooky flavour".

Based on the results and statistical analysis of the same, it was inferred that the semiscalding treatment was best as far as the organoleptic properties of the finished product were concerned. Since the semi-trained panel failed to detect exact time/temperature combination in this treatment for all the eating quality parameters,more work is necessary to come to a definite conclusion.

* CHAPTER V *

SUMMARY AND CONCLUSION

Studies on standardization of different scalding techniques for processing poultry were conducted with an aim, (i) to assess the best scalding time-temperature schedule to be followed while processing different species of poultry commonly used for meat purposes, (ii) pin point exact time-temperature schedule to be followed for different age group of poultry while processing, and (iii) bring out the advantages and disadvantages in the techniques in relation to keeping quality and organoleptic acceptability of the finished products.

The studies revealed that dressing percent of adult chicken was highest (67.39 $\pm$ 1.397 %) for the time-temperature combination of 60°C/60 sec. which was significantly different from all other time-temperature combinations except 77°C/120 sec. Since the latter time-temperature combination had adverse effect on grading, it was found that 60°C/60 sec. was a suitable time-temperature combination which can be adopted safely while dressing adult chicken. The salient grading defects such as pin feathers, cuts, tears and missing skin at the scalding treatment of 60°C/60 sec. was minimum. Most of the carcasses could be classified as 'A' grade and very few as 'C' grade according to U.S.D.A. Standard. So from the angle of grading defect, 60°C/60 sec.was also found to be best. Similarly in case of adult ducks, the highest dressing percentage was obtained in the treatment 60°C/120 sec. This treatment was significantly different from other subscalding methods viz. 60°C/60 sec. and 60°C/90 sec.but it showed nonsignificant difference with 77°C/90 sec., 77°C/120 sec., 53°C/60 sec. and 53°C/90 sec. Yet, 60°C/120 sec. was preferred as it gave the highest dressing percentage and less grading defects, such as cuts, tears and missing skin in the finished products.

With respect to standardization of different scalding techniques for different age groups of poultry, a comparison was made between adult chickens and broilers. Conclusion about the best time temperature combination for scalding has already been drawn for adult chicken. For broilers, the dressing percentage was highest at the scalding treatment of 60°C/60 sec. and the next higher result in 53°C/120 sec. The latter treatment was preferred as it kept the skin intact and had least grading defects. Also it was not statistically significant from 60°C/60 sec. Hence, the semi-scalding method of 53°C/120 sec. produced the best results for chicken broilers.

Keeping quality studies in adult chickens showed that though the initial total plate count was relatively higher than semiscalding treatments, after storage the increase in number of organisms was less at $60^{o}C/60$ sec. treatment group. The microbial multiplication during storage in relation to coliform counts, Streptococcus faecalis count and total mould count was also less in the scalding treatment of $60^{o}C/60$ sec., while comparing it with the influence of other scalding methods. So $60^{o}C/60$ sec. was found superior for adult chicken. In case of adult ducks, the initial total plate count for $60^{o}C/120$ sec. was relatively higher than $53^{o}C/60$ sec. and lower than $77^{o}C/120$ sec. However, after storage of three months, the increase in the number of organisms was lowest in $60^{o}C/120$ sec. which was also true for coliform count, Streptococcus faecalis count and total mould count. So $60^{o}C/120$ sec. scalding treatment was found to be the best. While considering bacterial condition in chicken broilers, there was slime formation and off-odour development due to the influence of hard scalding treatments after three months of storage. Total plate count was less in semi-scalding treatments than subscalding treatments. But $53^{o}C/120$ sec. gave the best result while considering the increase in the number of organisms after storage. Same result was found for coliform counts, Streptococcus faecalis count and total mould count.

Scalding effect on the organoleptic properties of poultry meat obtained for adult chickens indicated that the subscalding treatment 60°C/60 sec. was better for leg as well as breast muscle when considered in total. So, this may be taken as best time temperature combination. Based on the findings and statistical analysis of adult ducks, the organoleptic value of both breast and leg muscle was better in the subscalding temperature with timings varying from 60 to 120 sec. As the semi-trained taste panel employed were new to the use of duck meat, it was difficult to pin point time-temperature combination (scalding) which would give the best organoleptic characters of the finished product. However, more work may be needed to come to a definite conclusion. Statistical analysis for the organoleptic properties of chicken broiler meat, showed that semi-scalding treatments were better. Exact pin pointing of time temperature schedule was difficult as far as eating quality parameters were concerned. So, more work is necessary to come to a definite conclusion.

BIBLIOGRAPHY

Aert, J.V. 1977. Compensatory growth after protein under nutrition of large turkeys. Revue de I' Agriculture. 30(4):991-1015.

American Public Health Association, 1960. Standard methods for the examination of dairy products, 11th edition, New York.

Anon. 1953. Considerations in the use of hard-scald, sub-scald and semi-scald methods in dressing poultry. U.S.Dept.Agr. Mimeo.

Arafa, A.S., Wilson, H.R., Janky, D.M. and Oblinger, J.L. 1978. Quality characteristics of Bobwhite quail scalded at different times and temperatures. J.Food Sci. 43(3): 870-873.

Arora, S.P., Sushil Kumar and Rai, P.S. 1972. The relationship of dressing yield to some of the physical carcass characteristics in chicks. J. Food Sci. and Technol. 9(2):54-56.

Arumugam, M.P. and Panda, B. 1971. Processing and inspection of poultry. Part I. Summer Institute in Meat Technology held at IVRI Izatnagar, 1970.

Ayres, J.C., Ogilvy, W.C. and Stewart, G.F. 1950. Post-mortem changes in stored meats 1. Microorganisms associated with development of slime on eviscerated cut up poultry. Fd. Technol. 4:199-205.

Ayres, J.C. 1959. Effect of sanitation, packaging and antibiotics on the microbial spoilage of commercially processed poultry. Iowa State J. Sci. 34:27-46.

Ayres,J.C., Walker,H.W., Fenelli,M.J., King,A.W. and Thomas,F. 1956. Use of antibiotics in prolonging storage life of dressed chicken. Food Technol. 10:563.

Ayres,J.C. 1966. Microbial implications in processing of poultry. Second Intl. Cong. Food Sci. and Technol., Warsaw, Poland, 137-158.

Baker,R.C., Margolf,P.H. and Callenback,E.W. 1950. Length of starvation period as it affects bleeding of poultry. Poult. Sci. 29:747.

Baker,R.C. 1954. Effect of different methods of scalding, cooling and freezing on the appearance of ready-to-cook poultry carcasses. Poult. Sci. 33:1040.

Baker,R.C. 1955. You can freeze poultry carcasses without discolouration. Ameri. Egg and Poultry Review. 17:55.

Balsano,R. 1978. Hygiene and sanitary improvement in processing of fresh poultry and pig meat. Industrie Alimentari. 17(11):851-854.

Barnes,E.M. 1960. Progress in Ref. Sci. and Tech. 3, 97.

Bartels,H. and Wohner,H.P. 1972. Important points in poultry slaughter hygiene. Fleischwirtschaft. 52(12): 1583-1587, 1590.

Benjamin,W., Gwin,M., Faber,L. and Termohlen,D. 1960. Marketing poultry products. 5th ed. John Wiley and Sons, Inc. Publishers, New York, pp. 147.

Blankenschip,L.C. 1977. Attachment characteristics of clostridium perfringens spores to broiler carcass skin. Abstracts of the annual meeting of the American Society of Microbiology. 77:245.

Bobset,D., Greenberg,J. and Gezon,H.M. 1958. J.Am.Vet. A.M. 133:435.

Bolder,N.M. 1976. The water uptake of broilers prior to chilling. FSTA 8:7S 1080 (Lecture).

Bouthilet,R.J. 1949. A note on the nature of a flavour constituent from poultry meat. Food Technol. 3:118-119.

Bouthilet,R.J. 1950. Chicken flavour. Separation and concentration of its volatile components from broth. Food Res. 15:322-325.

Bouthilet,R.J. 1951 a. Chicken flavour. The fractionation of the volatile constituents. Food Res. 16:137-141.

Bouthilet,R.J. 1951 b. Chicken flavour. The source of the meat flavour component. Food Res. 16:201-204.

Brant,A.W. 1963. Chilling poultry. A review. Poultry process. Mktg. 69(5):14-22.

Casle,J.O., May,K.N. and Powers,J.J. 1965. Effect of three chilling methods on bacteriological, organoleptic and physical properties of broiler chicken. Fd. Technol. 19:859-861.

Childs,R.E. and Walters,R.E. 1962. Methods equipment for eviscerating chickens. U.S.Dept.Agr.Mktg.Res. Rept.549.

Choo,C.G. and Thiam,T.L. 1973. The effect of age and pre-slaughter conditions on tenderness of poultry meat. Malayasian Agricultural Research. 2(1):53-57.

Clark,D.S. 1968. Growth of psychro-tolerant pseudomonas and Achromobacter on chicken skin. Poult.Sci. 47(5):1575-1578.

Davis,L.L. and Coe,M.E. 1954. Bleeding of chickens during killing operations. Poult.Sci. 33:616-619.

Dawson,L.E., Mallmann,W.L., Frang,M. and Wallers,S. 1956. The influence of chlorine treatments on bacterial population and taste panel evaluation of chicken fryers. Poult.Sci. 35:1140.

Dawson,L.E. and Stadelman,W.J. 1960. Microorganisms and their control on fresh poultry meat. Mich. State Univ. NCM-7 Tech. Bull. 278.

Dean,P., Sutton,H. and Proudfoot,F.G. 1972. The effect of environmental flock treatments on broiler carcass quality. Poult. Sci. 51(4):1476-1477.

Denes,A. 1979. Extraneous water content of poultry products. Baromfitenyesztes es Feldolgozas. 26(1):27-38.

Dodge,J.W. and Stadelman,W.J. 1959. Postmortem ageing of poultry meat and its effect on the tenderness of breast muscles. Fd. Technol. 13:81-84.

Drewinak,E.E., Howe,M.A., Garesline,H.E. and Bansch,E.R. 1954. USDA Cir. No. 930.

Duncan,D.B. 1955. Multiple range and multiple F tests. Biometrics 11:1-42.

Ehinger(Echinger),F. 1977. Effect of CO_2 and NH_3 concentration and transport on broilers. Proceedings of the European meeting of meat research workers. No. 23, B 2; 1-B2: 19.

Eklund,M.W., Spencer,J.V., Sauter,E.A. and George,M.M.1961. The effect of different methods of chlortetracycline application on the shelf-life of chicken fryers. Poult.Sci. 40:924-928.

Elliot,R.P. and Michener,H.D. 1961. Microbiological standards and handling codes for chilled and frozen foods. A review. Appl. Microbiol. 9: 452-468.

Essary,E.O., Moore,W.E.C. and Kramer,C.Y. 1958. Influence of scald temperatures, chill times and holding temperatures on bacterial flora and shelf-life of freshly chilled tray pack poultry. Fd.Technol. 12:684.

Essary,E.O. and Howes,C.E. 1960. Bacterial flora of poultry kidneys and effects of kidney removal on yield and shelf-life. Poult.Sci. 39:56-59.

Esselen,W.B., Levine,A.S. and Pflug,I.J. 1955. Fast freeze, tight pack guard poultry surface colour. Food Engg. 27:99.

Firstenberg,E.R., Notermans,S., Thiel,F., Henstra,S. and Kampelmacher,E.H. 1979. Scanning electron microscopic investigation into the attachment of bacteria to teats of cows. J.Food Protection. 42: 305-309.

Fletcher,D.L.,and Thomason,D.M. 1980. The influence of environmental and processing conditions on the physical carcass quality factors associated with oily bird syndrome. Poult. Sci. 59(4):731-736.

Fromm,D. 1959. An evaluation of techniques commonly used to quantitatively determine the population on chicken carcasses. Poult.Sci. 38:887-893.

Fry,J.L., Bennet,G. and Stadelman,W.J. 1958. The effect of age,sex, and hormonization on the flavour of chicken meat. Poult.Sci. 37:331-335.

Gainer,J., Stewart,G.F. and Lowe,B. 1951. Effect of hand and machine massage on the tenderness of poultry muscles aged for short time periods. Food Res. 16:469-473.

Galton,M.M., Mackel,D.C., Lewis,A.W., Haire,W.C. and Hardy,A.V. 1955. Salmonellosis in poultry and poultry processing plants in Florida. Am.J.Vet. Res. 16:132-137.

Gey,K. and Pingel,H. 1977. Effects of scalding temperature and cooling procedure on quality of duck and goose meat. Fleisch. 31(7):134-136.

Graf,R.L. and Stewart,G.F. 1953. Slack versus subscald for broilers. Poult.Processing and Marketing 59:12-13, 20, 34.

Grossklaus,D. 1972. Poultry hygiene problems, breeding, keeping, slaughtering, packaging. J.Fleischwirtschaft. 52(8):1011-1013.

Gunderson,M.F., McFadden,H.W. and Kyle,T.S. 1954. The bacteriology of commercial poultry processing,Burg. Pub. Co., Minneapolis, Minnesota.

Gupta,S.C., Aggarwal,C.K., Pal,R.N. and Panda,P.C. 1978. Effect of processing on dressing yield of White leghorn cockrels. Rev. of Agro-Ani.Sci. and Health. III (4):175-180.

Gupta,S.C., Aggarwal,C.K., Pal,R.N. and Panda,P.C. 1978. Effect of pre-slaughter fasting and post-slaughter ice-chilling on the dressing yield of white pekin ducks. HAU J. Res. 8(3):210-215.

Gwin,J.M. 1950. The subscald method of dressing poultry. Amer. Egg and Poultry Review. 11(11):8, 10.

Gwin,J.M. 1951 a. A report of progress on the subscalding method of dressing poultry. Amer. Egg and Poultry Review. 12(10):14, 73.

Gwin,J.M. 1951 b. The weight and quality of freshly dressed poultry as affected by dressing, cooling, holding. Amer. Egg and Poultry Review. 12(2):38, 40.

Gwin,J.M. 1952. Subscalding saves pinning labour. U.S.Egg Poult. Mag.58(1):15.

Haleem,M.A., Madhawaraj,M.S. and Srinivasan,S.C. 1970. Technological advances in broiler production and processing influencing quality. Poult. Guide.7(6): 49-55.

Haleem,M.A., Madhawa Raj,M.S. and Ramanna,N. 1971. Poultry production and processing at CFTRI. Research Review. Poult. Guide, 8(8):13-15.

Haleem,M.A. and Madhawa Raj,M.S. 1972. Studies on the dressed, eviscerated and cut-up parts yield of four different types of commercial broilers. The Ind. Poult.Gaz. 50(2):52-68.

Hamm,D. 1972. Characteristics of effluents in ten southeastern poultry processing plants. Poult. Sci. 51(3):825-829.

Hanson,H.L., Campbell,A.A., Kraft,A.A., Gilpin,G.L. and Harkin,A.M. 1960. The flavour of modern and old type chickens. Poult.Sci. 38:1071-1078.

Hathaway,H.E., Champagne,G.B., Watts,A.B. and Upp,C.W. 1953. Meat yield of broilers of different breeds, strains and crosses. Poult.Sci. 32:968-977.

Heath,J.L. 1972. Xanthophyll composition and colour of broiler skin after scalding. Poult.Sci. 51:1817.

Heath,J.L. and Thomas,O.P. 1973. The xanthophyll content and colour of broiler skin after scalding. Poult. Sci. 52:967-971.

Heath,J.L. 1973. The influence of temperature and length of exposure to scald water on the xanthophyll content and colour of broiler skin. Poult.Sci. 52:2038.

Heath,J.L. and Thomas,O.P. 1974. The effect of feather removal during processing on the xanthophyll content of broiler skin. Poult.Sci. 53(1):291-295.

Heath,J.L. and Thomas,O.P. 1974. The effect of scalding condition on the xanthophyll content and colour of broiler skin. Poult.Sci. 53(5):1880-1885.

Heath,J.L. and Wabeck,C.J. 1975. The effect on xanthophyll content and colour of broiler skin when scald additive concentration was measured by pH. Poult. Sci. 54(4):1288-1292.

Henry,W.R. and From,D. 1958. Economic aspects of prolonged broiler chilling. N.Carolina State Coll.A.E. Inform.Ser. 67.

Hood,M.P., Rowan,W.S., Thomason,D.W. and Mize,J.J. 1955. Graded broilers in marketing channels in Georgia. Georgia Agric.Expt.Sta.Bull.N.S. 7.

Hughes,B.L. and Jones,J.E. 1980. Raw and steam cooked carcass yields of Guinea fowl. Poult.Sci.59: 657-658.

Ischhiramani,R.S. 1977. Preparation of ready-to-cook chicken. Poult.Guide 14(9):37-41.

Jaap,R.G., Renard,M.M. and Buckingham,R.D. 1950. Dressed and eviscerated meat yields from chickens at twelve weeks of age. Poult.Sci. 29:874-880.

Jain,P. 1971. Killing broilers for market. Poult.Guide 8(6):23-24.

James,M.G., Robert,E.P. and Francis,A.P. 1950. The effect of dressing temperature of poultry on water absorption. Poult.Sci. 29:761.

Jeremiah,L.E., Smith,G.C. and Carpenter,Z.L. 1971. Palatability of individual muscles from ovine leg steaks as related to chronological age and marbelling. J.Food Sci. 36:45-47.

Johnson,A.R. 1971. Review of poultry marketing and product technology. Poult. Guide 8(6):40-45.

Jull,M.A. and Maw,W.A. 1923. Determination of dressed, drawn and edible percentage of various kinds of domestic birds. Sci. Agri. 3:329-338.

Jull,M.A., Phillips,R.E. and Williams,C.S. 1943. Cited by Mathur,C.R. and Ahmed,M.T. 1968. Ind.Vet.J. 45: 1033.

Jull,M.A., Phillips,R.E. and Williams,C.S. 1943. U.S.Egg and Poult.Mag. 49:364.

Jull,M.A. 1951. Poultry Husbandry, 3rd Ed.Hegnaw Hill Book Co. Inc. New York, Toronto, London.

Kahle,H.S. and Gray,L.R. 1956. Utilization and disposal of poultry byproducts and wastes. USDA, AMS Marketing Research Rept. 143.

Kaufman, V.F., Klose,A.A., Bayne,H.G., Pool,M.F. and Lineweaver,H. 1972. Plant processing of subatmospheric steam scalded poultry. Poult.Sci.51(4): 1188-1194.

Keel,J.E. and Parmelle,C.F. 1968. Improving the bacteriological quality of chicken fryers. J.Milk Food Technol. 31:377-381.

Khlebnikov,V.I., Plyasov,Yu.A. and Makoveev,I.I. 1979. Selecting optimal conditions for scalding and plucking of poultry. Myasnya Industrya SSSR,No.10:41-43.

Klose,A.A. and Pool,M.F. 1953. Effect of scalding temperature on quality of cooked turkey and of storage stability of frozen turkeys. Poult.Sci. 32:909.

Klose,A.A. and Pool,M.F. 1954. Effect of scalding temperature on quality of stored frozen turkeys. Poult. Sci. 33:280-289.

Klose,A.A. and Pool,M.F. 1956. Effect of freezing conditions on appearance of frozen turkeys. Fd. Technol.10:34.

Klose,A.A., Hanson,H.L., Pool,M.F. and Lineweaver,H. 1956. Poultry tenderness improved by holding before freezing. Quick Frozen Foods. 18:95.

Klose,A.A., Pool,M.F., Wiele,M.B., Hanson,H.L. and Lineweaver,H. 1959. Poultry tenderness. 1. Influence of processing on tenderness of turkeys. Food Technol. 13:20-24.

Klose,A.A. 1960. In Nutritional Evaluation of Food Processing. edited by Robber S. Harris and Harry Von Loesecke, New York, London, John Wiley and Sons. Inc. Chapter 7B. Effects of processing on poultry products, pp. 277.

Klose,A.A., Mecchi,E.P. and Pool,M.F. 1961. Observations on factors influencing feather release. Poult. Sci. 40:1029-1036.

Klose,A.A., Mecchi,E.P. and Pool,M.F. 1962. Feather release by scalding and other factors. Poult. Sci. 41:1277-1282.

Klose,A.A., Kaufman,V.F. and Pool,M.F. 1971. Scalding poultry steam at sub-atmospheric pressures. Poultry Sci. 50:302-304.

Knapp,B.G. and Newell,G.W. 1961. Effect of selected factors on feather removal in chickens. Poult.Sci. 40:510-517.

Kotula,A.W., Drewniak,E.E. and Davis,L.L. 1957. The effect of carbondioxide immobilization on the bleeding of chickens. Poult.Sci. 36:585-589.

Kotula,A.W., Banwart,G.J. and Kinner,J.A. 1967. Effect of post-chilling washing on bacterial counts of broiler chickens. Poult.Sci. 46:1210-1216.

Kraft,A.A. 1971. Microbiology of poultry products. J.Milk Food Technol. 34(1):23-29.

Kumar,J., Acharya,R.M. and Tarhan,S.S. 1971. Collection and evaluation of native fowl germplasm. X.Carcass yield and carcass quality of indegenous breeds, exotic breeds and their reciprocal crosses. Ind. J. Ani.Sci. 41(12):1138-1143.

Lahellec,C. 1976. Influence of some processing factors on hygienic quality of poultry meat. FSTA (1976), 8:7S 1080 (Lecture).

Larmond,E. and Moran,E.T. 1969. Eating quality of chicken broilers as influenced by age and sex. Canadian Institute of Food Tech. J. 2(4):185-187.

Larmond,E., Moran,E.T. and Kim,C.I. 1970. Eating quality of two basic breeds of broiler chickens and their crosses. Canadian Inst. of Food Tech.J. 3(2):63-65.

Lee,Y.B., Hargus,G.L., Hagberg,E.C. and Forsythe,R.H.1976. Effect of antemortem environmental temperatures on postmortem glycolysis and tenderness in excised broiler breast muscle. J. Food Sci. 41(6):1466-1469.

Leong,K.C., Sunde,M.L., Bird,H.R. and Weckel,K.G. 1958. Taste panel evaluation of the effect of added fat on the flavour of chicken meat. Poult.Sci. 37: 1170-1172.

Levinger,I.M., Soroker,I. 1974. The use of a chemical agent to facilitate plucking in the Kosher poultry processing plant. Refuah Verianarith. 31(1):36-39, 17-19.

Lillard,H.S. 1973. Contamination of blood system and edible parts of poultry with clostridium perfringes during water scalding. J. of Food Sci. 38(1): 151-154.

Lillard,H.S., Klose,A.A., Hegge,R.I. and Chew,V. 1973. Microbiological comparison of steam (at subatmospheric pressure) and immersion scalded broilers. J. of Food Sci. 38(5):903-904.

Lineweaver,H. and Klose,A.A. 1952. Sub-scalding versus semi-scalding. Turkey World. 27(11):18, 66.

Lineweaver,H. 1961. Chicken flavour in processing. Flavour chemistry symposium. Campbell. Soup Co.,Camden,N.J.

Lockhead,A.G. and Landerkin,G.B. 1935. Bacteriological studies of dressed poultry. 1. Preliminary investigations of bacterial action at Chill temperature. Scientific Agric. 15:765-69.

Lowe,Belle. 1941. Edible meat of two weights of roasters. U.S.Egg and Poultry Mag. 47:95-102.

Loy,W.C. 1956. Proper methods for handling frozen poultry and eggs. Refrig. Eng. 64:58.

Mahadevan,T.D. and Bose,S. 1951. The determination of the percentage of edible flesh in the Rhode Island Red, White Leghorn and desi (indigenous) cockrels at different stages of growth. Ind.J.Vet.Sci.21:39-41.

Mallmann,W.L., Dawson,L.E., Sultzer,B.M. and Wright,H.S. 1958. Studies on microbiological methods for predicting shelf-life of dressed poultry. Food Technol. 12:122-126.

Margolf,P.H., Callenbach,E.W., Miller,R.C., Nicholas,J.E., Perry,J.S., Cone,J.F., Murphy,J.F., Dodds,M.L. and Grace Bennett 1956. The effect of type of scald and wrap on the market quality of frozen poultry. Poult. Sci. 35:37-46.

Mathur,C.R. and Ahmed,M.T. 1968. A study of processing losses and meat yields of broilers at 10 weeks age. The Ind.Vet.J. 45:1033-1037.

May,K.N. 1961. Skin contamination of broilers during commercial evisceration. Poult.Sci. 40:531-536.

May,K.N. 1962. Bacterial contamination during cutting and packaging chicken in processing plants and retail stores. Fd. Technol. 16:89-91.

May,K.N., Irby,J.D. and Carman,J.L. 1962. Fd.Technol.16:66.

May,K.N. 1969. Microbial counts on chicken purchased at retail. Poult.Sci. 48:1762-1764.

McCarthy,P.A., Brown,W.B. and Hamdy,M.K. 1962. Microbiological studies of bruised tissues. Food Sci.28: 245-253.

Mead,G.C. and Impey,C.S. 1970. The distribution of clostridia in poultry processing plants. Brit.Poult.Sci. 11(3):407-414.

Megally,M.A., Harrington,R.B. and Stadelman,W. 1969. The effects of estradial-17B monopalmitate in yields and quality of chicken roasters. Poult.Sci. 48(1): 130-136.

Meller,D.B., Stringer,P.A. and Mountney,G.J. 1958. The influence of glycogen on tenderness of broiler meat. Poult. Sci. 37:1028-1033.

Mohapatra,C.M., and Singh,R.P. 1980. Processing and marketing of broilers. Poult.Guide 17(11):115-120.

Morris,T.G. and Ayres,J.C. 1960. Incidence of salmonellae on commercially processed poultry. Poult.Sci. 39:1131-1135.

Mountney,G.J. 1966. in Poultry products technology, pp.64. Westport Connecticut, AVI Publishing Co. Inc.

Mountney,G.J. 1976. in Poultry Products Technology. Second Ed. Westport, Connecticut, The AVI Publishing Co. Inc. pp. 67, 153, 72, 49, 48.

Mulder,R.W.A.W. and Dorresteijn,L.W.J. 1977. Hygiene during scalding of broilers. Fleischwirtschaft. 57(12): 2220-2222, 2169, 2172.

Mulder,R.W.A.W., Dorresteijn,L.W.J. and Brock,J.Vander 1978. Cross contamination during the scalding and plucking of broilers. Brit.Poult.Sci. 19(1): 61-70.

Mundt,J.O., Stokes,R.L. and Goff,O.E. 1954. The skin of broilers as a barrier to bacterial invasion during processing. Poult.Sci. 38:799-802.

Murray,J.G. 1956. A technique for making dilutions. J.appl. Bact. 19:212-214.

Nagel,C.W., Connolly,R.J., Vaughn,R.H. and Stewart,G.F. 1958. Want to extend shelf-life? Here are some ways to do it. Proc. and Mktg. 65(1):14-15.

Nagel,C.W., Simpson,K.L., Ng,H., Vaughn,R.H. and Stewart, G.F. 1960. Microorganisms associated with spoilage of refrigerated poultry. Fd.Technol. 14:21-23.

Nakamura,R., Sekogucki,S. and Sato,Y. 1975. The contribution of intramuscular collagen to the tenderness of meat from chickens with different ages. Poult. Sci. 54(5):1604-1612.

Neb,Y.P. 1966. Processing and marketing of commercial broilers in U.S.A. Poultry Guide. 3(10):6-10.

Newell,G.W. and Shaffner,C.S. 1950. Blood loss by chickens during killing. Poult.Sci. 29:217-275.

Notermans,S. and Kampelmacher,E.H. 1974. Attachment of some bacterial strains to the skin of broiler chickens. Brit. Poult. Sci. 15:573-585.

Notermans,S. and Kampelmacher,E.H. 1975. Heat destruction of some bacterial strains attached to broiler skin. Brit. Poult. Sci. 16(4):351-361.

Notermans,S., VanLeusden,F.M. and van Schothorst,M. 1977. Suitability of different bacterial groups for determining faecal contamination during post scalding stages in the processing of broiler chickens. J.Appl.Bacteriol. 43:383-389.

Notermans,S., Firstenberg Eden,R. and van Schothorst,M. 1979. Attachment of bacteria to teats of cows. J. Food Protection. 42:228-232.

Notermans,S., Terbijhe,R.J. and van Schothorst,M. 1980. Removing faecal contamination of broilers by spray cleaning during evisceration. Brit.Poult. Sci. 21:115-121.

Panda,P.C., Haleem,M.A. and Panda,B. 1967. Incidence of breast blisters and breast bruisings in dressed poultry. J. Food Sci. and Tech. 4(2):76.

Panda,P.C. 1970. Bacteriological condition and shelf-life dressed poultry chilled in slush ice tanks containing polyphosphates. Ind. Fd. Packer. 24(6): 30-32.

Panda,B. 1971. Methods of handling, processing, inspection, evaluation, storage and quality control of broilers. Ind. Poult. Gaz. 55(1):21-27.

Panda,P.C. 1971. Bacteriological condition of dressed chicken during the process of retailing. Ind. Vet.J. 48(9):927-931.

Panda,P.C. and Sri Hari,S.C. 1971. Poultry marketing in India - An investigation. Paper presented at ICAR Workshop on Dressed Poultry and Piggery Products held at Poona, 15th to 17th Feb.,1971.

Panda,P.C. 1972. Factors influencing meat yield of eviscerated poultry - a review. Ind.Fd.Packer. 26(1):20-24.

Panda,P.C. 1973. Water absorption by slaughtered poultry. Cited in Poult.Adv. 5(10):51.

Panda,P.C. and Basu,S. 1973. "S. wichita" a new serotype isolated from poultry. Ind.J.Exptl.Biol.11(4):345.

Panda,P.C. 1973. Salmonella serotypes associated with dressed poultry marketed in India. Ind.J.Pub. Health. 17(1):27-28.

Panda,P.C. 1973. Effect of different methods of slaughter on the keeping quality of dressed chicken. Ind. Poult.Gaz. 57(2):35-38.

Panda,P.C. 1975. A review on microbiological aspects of dressed chicken. Indian Food Packer. XXIX (2): 14-20.

Panda,P.C. 1977. Grading of ducks and turkeys. Poult.Guide. 15(9):61-66.

Panda,B., Singh,R.P. and Srivastava,A.K. 1979. Processing preservation of quail products. Poult. Guide 16(11): 85-97.

Panda,P.C. 1979. Development of poultry technology in India. Paper presented at All India Poultry Science Symposium, Hissar. 8th to 10th Dec.,1979.

Panda,P.C. 1980. Frozen poultry. Poult. Guide. 17(11): 171-174.

Pandey,N.K. and Singh,R.P. 1979. Factors influencing poultry meat flavour. Poultry Guide. 16(5):39-41.

Parnell,E.D., Butler,O.D. and Cover,S. 1950. Storage tests with unwrapped frozen fryers. Texas Agric.Exp. Sta.Progress Rept. 1270.

Patrick,T.E., Goodwin,T.L., Collins,J.A. and Wyche,R.C. 1971. Steam versus hot water scalding in reducing bacterial counts on broilers. Poult.Sci. 50: 1616-1617.

Patrick,T.E., Goodwin,T.L., Collins,J.A., Wyche,R.C. and Love,B.E. 1972. Steam versus hot water scalding in reducing bacterial loads on the skin of commercially processed poultry. Appl. Microbiol.23(4): 796-798.

Patterson,J.T. 1968. Chorination of water used for poultry processing. Brit.Poult.Sci. 9:129-133.

Pearce,J.A. and Lavers,C.G. 1949. Frozen storage of poultry. V. Effects of some processing factors on quality. Canadian J.Res.F. 27:253-265.

Pelczynska,E. 1974. Tenderness of poultry meat in relation to muscle groups, age, carcass quality grade and connective tissue content. Lebensmittel-Wissenschaft + Technologie. 7(6):343-344.

Pelletan,G.M. 1972. Bacterial contamination of turkeys during slaughtering. Review Technique des Veterinaires Hygienistes de I' Alimentation. 10(85):19-20.

Pietzsch,O. and Levetozow,R. 1974. Fleischwirtschaft.54(1): 76.

Pippen,E.L., Gampbell,A.A. and Streeter,I.V. 1954. Flavour studies. Origin of chicken flavour. J.Agric. Food Chem. 2:364-367.

Pool,M.F., Mecchi,E.P., Lineweaver,H. and Klose,A.A.1954. The effect of scalding temperature on the processing and initial appearance of turkeys. Poult. Sci. 33:274-279.

Pool,M.F., deFremery,D., Campbell,A.A. and Klose,A.A.1959. Poultry tenderness. II. Influence of processing on tenderness of chicken. Food Technol. 13:25-29.

Radhakrishnan,R. and Panda,P.C. 1977. Studies on pathogenicity and drug sensitivity of E.coli strains isolated from dressed poultry. Ind.J.Poult.Sci.XII (iii):34-39.

Ramnani,A. 1978. Poultry processing. Poult.Guide. 15(6):55-58,

Ranganathan,M., Arumugam,M.P. and Natarajan,R. 1967. A study on the dressing of Rhode Island Red,White Leghorn and Desi Cockrels. The Ind. Vet.J.44: 956-961.

Ranken,M.D.G., Clewlow,G., Shrimpton,D.H. and Stevens,B.J.H. 1965. Chorination in poultry processing. Brit. Poult.Sci. 6:331-337.

Reimer,F. 1977. Scalding agent. German Federal Republic Patent Application. 2:542, 891.

Report of the National Commission on Agriculture, 1976. Part VII: 500. Animal Husbandry, Goverment of India, Ministry of Agriculture and Irrigation, New Delhi.

Reynolds,H.J., Johnson,G.W., Zebarth,R. and Nichols,W. 1953. Poultry processing practices. Gordon Johnson Co. Kansas City.

Rice,J.E. and Betsford,H.E. 1956. Practical poultry management. 6th ed. John Wiley and Sons. Inc. Publishers, New York, pp.202.

Ristic,M. and Schon,L. 1977. Changes in the muscle pH of broilers in relation to the year of production. Archivfur Geflugelkunde, 41(6):253-256.

Ristic,M. 1978. Effects of scalding temperature and the cooling process on the quality of broiler and turkey meat. Fleisch wirtschaft. 58(5):811-816.

Sadasivam,P., Manikam,R. and Kathaperumal,V. 1980. Studies on the dressing data in hybrid broiler chicken. Poult.Adv.13(4):65-66.

Salmon,R.E. 1980. Effects of methods of processing and chilling of turkey carcasses on processing losses, water absorption and yields. Br. Poult.Sci.21: 253-256.

Salzer,R.H., Kraft,A.A. and Ayres,J.C. 1967. Microorganisms isolated from turkey giblets. Poult.Sci. 46: 611-615.

Sathe,B.S. 1970. Factors influencing broiler meat yield. Poult. Guide. 7(6):25-28.

Scholtyssek,S., Heimbach,P. and Berner,H. 1970. Investigation of carcass quality. Fleisch wirtschaft 50(1):77-79.

Shannon,W.G., Marion,W.W. and Stadelman,W.J. 1957. Effect of temperature and time of scalding on the tenderness of breast meat of chicken. Food Tech. 11: 284-286.

Singh,R.P. and Mohapatra,C.M. 1979. Tenderization of poultry meat. Poult.Guide 16(6):25-28.

Singh,R.P., Shrivastava,A.K. and Panda,B. 1980. Studies on slaughter characteristics of Japanese quail (Coturnix coturnix japonica) at different stages of growth. Ind. Poult.Gaz. 64(1):12-17.

Snyder,E.S. and Orr,H.L. 1964. Poultry meat processing, quality factors,yields. Ontario Dept.Agric.

Souri,B.N., Gopalkrishnan,C.A. and Md.Habibullah Khan 1972. Studies on dressing data and on relationship of live weight and dressed weight in desi birds. The Ind. Vet. J. 49:920-927.

Straka,R.P. and Stokes,J.L. 1957. Rapid destruction of bacteria in commonly used diluents and its elimination. Appl.Microbiol. 5:21-25.

Sundararasu,V. 1979. Processing and grading of ready-to-cook chicken. Poult.Guide. 16(7):54-58.

Surkiewicz,B.F., Johnston,R.W., Moran,A.B. and Kraumm,G.W. 1969. A bacteriological survey of chicken eviscerating plants. Food Technol. 23:1066-1069.

Tarver,F.R. and May,K.N. 1963 b. Effect of slaughter technique, immersion scald and refrigerated storage on bacterial counts of poultry sacs. Poult. Sci. 42:1141-1145.

Thomason,David,M. 1978. Georgia poultry tips. Univ. of Georgia, Athens, G.A.

Thomason,D.M. 1979. Yield and moisture uptake of broilers processed at two scald temperatures. Poult.Sci. 58:1025-1026.

Thompson,J.E. and Kotula,A.W. 1959. Contamination of the air-sac areas of chicken carcasses and its relationship to scalding and method of killing. Poult. Sci. 38:1433-1437.

Union Ministry of Agriculture, Government of India,New Delhi, 1977. The potential of broiler industry in India. Poultry Guide. 14(6):31-34.

U.S.Dept.Agri.Handbook 31, 1961. Summary of specifications for standard of quality for individual carcasses of ready-to-cook chicken.

Veerkamp,C.H. 1972. Combined scalding/plucking process: a new development in poultry slaughtering. Voedingsmiddelentechnologie. 3(22):103-105.

Vernon,W.M. 1923. Losses sustained in preparing poultry for the table. Poult.Sci. 3:187-193.

Wagen,R.M. and Skala,J.H. 1968. Tenderness and maturity in relation to certain muscle components of white Leghorn fowl. J. Food Sci. 33:613.

Walker,H.W. and Ayres,J.C. 1956. Incidence and kinds of organisms associated with commercially dressed poultry. Appl.Microbiol. 4:345-349.

Walker,H.W. and Ayres,J.C. 1959. Microorganisms associated with commercially processed turkeys. Poult.Sci. 38:1351-1355.

Walter,R.E., May,K.N. and Rodgers,P.D. 1963. Relations of weights and sizes of broiler parts to carcass weights. U.S.Dept.Agr., Agri.Mktg.Ser., Mktg. Res.Rept. 604.

Wasserman,A.E. 1972 a. Thermally produced flavour components in the aroma of meat and poultry. J.Agr. Food Chem. 20(4):737-741.

Wesley,R.L. 1978. Virginia polytechnique institute,Blacksburg, Va, from experience and from research reported in the Journal of Poultry Science(10/23/78).

Wilder,A.N. and MacCready,R.A. 1966. Isolation of Salmonella from poultry, poultry products and poultry processing plants in Massachusettes. New Eng. J. Med. 274:1453-1460.

Wilson,E., Raffenberger,R.S., Potter,M.J. and Lewis,K.H. 1961. Prevalence of Salmonella in meat and poultry products. J.Inf.Dis. 109:166-177.

Winter,A.R. and Clements,P. 1957. Cooked edible meat in ready-to-cook poultry. J.Am.Diet.Assoc. 33:800-802.

Wise,R.G. and Stadelman,W.J. 1957. Effect of beating by mechanical pickers on the tenderness of poultry meat. Poult.Sci. 36:1169-1170.

Wise,R.G. and Stadelman,W.J. 1961. Tenderness of poultry meat. 2. Effect of scalding procedures. Poult. Sci. 40:1731-1736.

Woodburn,M. 1964. Incidence of Salmonella in dressed broiler fryer chickens. Appl.Microbiol. 12: 492-495.

York,L.R. and Mitchell,J.D. 1969. The effect of oestradiol-17 B monopalmitate and surgical caponization on production efficiencies, yields and characteristics of chicken broilers. Poult.Sci. 48(5): 1532-1536.

Ziegler,F. and Stadelman,W.J. 1955. The effect of different scald water temperatures on the shelf-life of fresh, non-frozen fryers. Poult.Sci. 34:237-238.

APPENDIX - I

Summary of specifications for standards of quality for individual carcasses of ready-to-cook chicken.

(Minimum requirements and maximum defects permitted)

Factor	A quality		B quality		C quality
1. Conformation	Normal		Practically normal		Abnormal
Breast bone	Slight curve, or dent		Dented, curved, slightly crooked		Seriously crooked
Back	Normal (except slight curve)		Moderately misshapen		Seriously crooked
Legs and wings	Normal		Moderately misshapen		Misshapen
2. Fleshing	Well fleshed, moderately long and rounded breast		Fairly well fleshed on breast and legs		Poorly fleshed
3. Fat covering	Well covered-considering class and part		Sufficient fat on breast and legs to prevent distinct appearance of flesh through skin		Lacking in fat covering over all parts of carcass.
	Breast and legs:	Elsewhere:	Breast and legs:	Elsewhere	
4. Pinfeathers:					
Nonprotruding pins and hair	Pract. free	Pract. free	Few scattered	Few scattered	Scattering
Protruding pins	Free	Free	Free	Free	Free

continued..

Factor	A quality		B quality		C quality
	Breast and legs:	Elsewhere:	Breast and legs	Elsewhere:	
5. Cuts, tears and missing skin[1]	Free	1½ in.	1½ in.	3 in.	No limit
6. Discolorations[2]	1 in.	2 in.	2 in.	4 in.	No limit[3]
7. Disjointed bones	1		1 or 2 if no broken bone		No limit
8. Broken bones	None		1 Non-protruding		No limit
9. Missing parts	Wing tips and tail		Wing tips, 2nd wing joint and tail		Wing tips, wings and tail.
10. Freezer burn	Few small (1/8 in. diam.) pockmarks		Moderate dried areas not in excess of 1/2 in. in diameter		Numerous pockmarks and large dried areas.

From: U.S. Dept. Agr. Handbook 31, (1961).

1 Total aggregate area of flesh exposed by all cuts and tears and missing skin.

2 Flesh bruises are not permitted on the breast and legs of A quality birds. Not more than one-half of total aggregate area of discoloration may be due to flesh bruises, (where permitted) and skin bruises in any combination.

3 No limit on size and number of areas of discoloration and flesh bruises if such areas do not render any part of the carcass unfit for food.

APPENDIX - II

Title of Investigation:

Date:

Dressing percentage and meat yield record:

1. Breed:
2. Sex
3. Age
4. Duration of fasting
5. Live weight
6. Weight after bleeding:

   Blood

7. Weight after defeathering:

   Feather:

8. Eviscerated weight:

   i) Visceral content:

   ii) Weight of Giblets:

9. i) Weight of Head:

   ii) Weight of Neck:

   iii) Weight of Feet:

10. Hot dressed weight:
11. Cold dressed weight:
12. Dressing percentage:

As percentage of live weight :

1) Hot dressed:

2) Head:

APPENDIX - II (continued)....

3) Legs:

4) Carcass + Neck:

5) Giblets:

   a) Heart :

   b) Liver :

   c) Gizzard:

Total =

<u>As percentage of dressed weight</u> :

1. Chilled carcass + Neck
2. Total Giblets
3. Total ready-to-cook.

APPENDIX - III

Animal Products Technology,
Haryana Agril. University,
Hissar.

Score Sheet for Taste Panel :

Name:

Date/Time:

Address:

Semi-trained Taste Panel/data under Haedonic scale:

Very desirable	...	9
Desirable	...	8
Moderately desirable	...	7
Slightly desirable	...	6
Neither desirable or Undesirable	...	5
Slightly undesirable	...	4
Moderately undesirable	...	3
Undesirable	...	2

continued...

APPENDIX - III (continued)...

Very undesirable ... 1

Code No.	Appearance	Flavour	Tenderness	Juiciness	Acceptability	Remarks
	1	2	3	4	5	6
1.						
2.						
3.						
4.						
5.						
.						
.						
.						
.						
.						

Please wash your mouth with clean water after tasting each sample.

Signature

Return to:

Professor and Head
Animal Products Technology
HAU, Hissar.