FORMULATION AND SHELF LIFE OF DUCK MEAT STICK

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"FORMULATION AND SHELF LIFE OF DUCK MEAT STICK"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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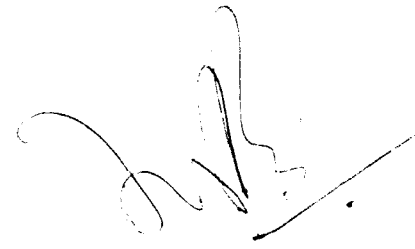
CERTIFICATE

Certified that the thesis, entitled "**FORMULATION AND SHELF LIFE OF DUCK MEAT STICK**" is a record of research work done independently by **Shri. K. Sangilimadan**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.



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Dedicated to my loving

Parents and Grand Parents

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INTRODUCTION

Poultry have become more important to human welfare today than ever before in history. Over 60 per cent of the human population in the world is underfed. Poultry products contain dependable and valuable source of life supporting nutrients in pure form.

Although there was phenomenal increase in the poultry population in India, the consumption of egg and meat had not increased greatly to the expectation of planners. The per capita annual availability of poultry meat was only 517 g (Anon, 1994) during the year 1993 which is far less in comparison to that of developed countries.

The limited variety of convenience foods and the scarcity of protein rich products at affordable prices lead to malnutrition among the weaker sections of population. The preparation of wide variety of value added products using spent birds will improve its consumer demand and overall acceptability. There is a preference for ready-to-eat or ready-to-cook meat products compared to the meat of spent birds as such. It will also fetch better returns for the farmer. Meat from spent birds which is generally tough can be made tender and more acceptable by comminution. The use of additives, seasoning and vegetable extenders for developing

various recipes suitable to the taste, food pattern and cooking styles of Indian consumers show tremendous scope for meat products technology in the country.

The demand for good quality ready-to-serve poultry products is fast increasing because of the changes in life style and socio-economic status of the society. In order to keep up the trend in poultry development, further processing and marketing of various poultry meat products have to be strengthened.

Mutton and cheavon although had strong hold among the non-vegetarians, its availability is gradually declining in the market and it is becoming costly year after year. Therefore dependency on chicken and duck meat is increasing day by day. Poultry meat has now become popular among majority of meat consumers in India since easy adulteration is not possible in the case of poultry meat. Moreover it is one of the cheapest animal protein sources available to mankind. With the increasing demand for animal protein sources, duck production will be able to contribute greatly to achieve the goal. The products prepared using duck meat and eggs will provide a good protein source in several regions.

In India, ducks are essentially grown for egg production. Therefore, duck meat available is essentially from spent ducks only. In as much as spent ducks contribute a major share of duck meat in India, it is appropriate that the production of

value added products using duck meat will be of high significance. In Kerala, duck rearing is practiced traditionally for several decades. However, the utilization of duck meat for the preparation of products is not common. Hence the preparation of products using duck meat will be of great value and challenging in this region.

In developed countries numerous preparations from poultry meat are commercially available and one such product that has gained popularity in the western market is poultry meat sticks. The recipe for poultry meat sticks developed in western countries may not be readily acceptable to the Indian palate. Moreover, the keeping quality of the sticks under Indian conditions has to be studied when commercial exploitation is planned.

A possibility for increasing poultry meat consumption is through the development of new convenience marketable food items. One such approach is the development of meat sticks. Therefore, the present investigation was taken up to examine the feasibility of preparing duck meat sticks from the deboned minced meat of desi spent ducks using recipes suitable to Indian consumers and to evaluate nutritional characteristics and shelf life of the product on storage under deep freezing temperature.

Review of Literature

REVIEW OF LITERATURE

This study involves the preparation of a ready-to-cook product from deboned minced meat of desi spent ducks. The evaluation of various characteristics of the product include shelf-life under storage conditions and periods of storage, chemical composition, cooking loss and organoleptic evaluation. In addition, attempts were also made to study the processing yields, losses, meat to bone ratio and abdominal fat deposition in desi spent ducks. The research work carried out on the above aspects is rather scanty. A brief review of the more recent and relevant literature on the above aspects is presented below.

Processing yields and losses

Eventhough numerous research reports are available on meat yields and losses of chicken, research work on these aspects in ducks is limited.

Yields of poultry vary considerably among lots even at the same stage of processing. Measurements especially methods for recording meat yields, yields of cut-up-parts and cooking yields have not been standardised. As a result it is often difficult to obtain comparable sets of data from different experiments.

Broadbent and Bean (1952) reported that the dressing loss and eviscerated yield of nine week old Pekin ducklings was 10.56 and 72.80 per cent respectively.

The net yield of meat from processed poultry is reported to be related to a variety of factors such as body conformation of bird (Jaap and Penquite, 1938); previous nutritional status of the bird (Harkin *et al.*, 1960); sex, age and strain (Fry *et al.*, 1962).

Snyder and Orr (1964) reported that per cent ready-to-cook and giblet yields averaged 70.3 and 5.5 respectively in Pekin ducks aged around eight weeks.

Orr (1969) reported that the dressing percentage and meat yield varied in ducks due to age, sex, breed, weight and grade.

Experimental studies of Wilson (1973) indicated that the edible weight represented approximately 70 per cent of dead weight in both sexes of Pekin ducks at 56 days of age.

Investigation by Luhman and Vogt (1976) in male and female Pekin ducks at seven, eight and nine weeks of age indicated that the ready-to-cook weight averaged 61.10 per cent.

Varadarajulu and Rao (1976) reported the percentage of carcass yield of desi ducks to be 60.40 and 58.80 respectively in males and females.

George *et al.* (1980) conducted experiments on desi ducks of nine week old and reported that the percentage ready-to-cook and giblet yield averaged 69.21 and 6.98 respectively. The mean per cent losses due to blood, feather and viscera were 7.27, 8.25 and 8.35 respectively in this study.

Clayton and Pawell (1979) carried out two trials in ducks (*Anas platyrhonchos*) and reported an eviscerated yield of 62.75 ± 0.37 and 62.50 ± 0.39 in males and 61.54 ± 0.37 and 61.57 ± 0.44 per cent in females in the two experiments respectively at 51 days of age.

Lewczwk *et al.* (1980) reported that the dressing percentage of 22 male and 22 female Pekin ducks averaged 63.50 and 64.30 respectively.

Narayanankutty *et al.* (1982) studying the processing yields and meat bone ratio in one year old crossbred (Khaki Campbell x Desi) female ducks reported that the per cent ready-to-cook and giblet yield averaged 68.27, 6.55 respectively. The meat bone ratio was 1.72. The authors also observed that the loss due to blood and feathers averaged 6.27 and 4.84 per cent respectively.

Kutty *et al.* (1983) compared the meat yields of spent hens (White Leghorn) and ducks (Khaki Campbell) aged 18 months and reported that mean live weight averaged 1370.75 ± 35.20 and 1214 ± 21.54 g respectively for spent hens and ducks. The mean percentage eviscerated and ready-to-cook yields were 59.98 and 63.92 respectively in spent hens and 61.76 and 69.0 in spent ducks. From the results of this study it was concluded that as poultry meat source, spent ducks offer equal or even better promise than spent hens.

Blood generally amounts to from 3.3 to 4.8 per cent and feathers from 4.8 to 8.5 per cent of the total carcass weight (Mountney, 1983).

Sahoo and Panda (1983) conducted experiments on Minikos female ducks of one year old and found that the mean percentage of blood, feather, visceral content, total inedible parts and giblet yields were 6.46, 5.26, 17.34, 37.99 and 5.90 respectively. The authors also observed that the mean live weight just before slaughter ranged from 994.0 ± 28.0 to 1084.0 ± 41.6 g. The per cent blood loss, feather loss, visceral content, giblet yield, total loss and eviscerated yields ranged from 5.03 to 6.46, 3.98 to 7.59, 13.56 to 19.25, 5.18 to 7.80, 32.31 to 39.63 and 60.8 ± 3.2 to 67.6 ± 0.9 respectively.

Ahmed *et al.* (1984) reported that the body weight at the time of slaughter averaged 1.51 and 1.32 kg respectively for

males and females of Khaki Campbell ducks aged 12 months. It was also reported that the hot carcass yield averaged 62.24 and 56.46 per cent in males and females respectively and chilled carcass yield averaged 66.59 and 61.70 per cent in males and females respectively and the mean per cent giblet yields averaged 5.71 and 7.03 respectively for males and females.

Brahma *et al.* (1985) studied the carcass characteristics of spent Indian Runner ducks and reported that the live weight averaged 1040 g and per cent blood, feather, giblet and eviscerated yields were 4.93, 12.42, 7.82 and 58.67 respectively.

Rao and Bulbule (1987) conducted studies on different breeds of ducks and the following observations were made. The mean per cent losses due to blood and feather were 3.49 and 6.88 respectively in Campbell ducks; the per cent dressing losses due to blood and feather averaged 13.20 and 11.80 respectively for Muscovy and Pekin ducks; the losses due to evisceration averaged 15.30, 21.11 and 27.10 percentages respectively for Muscovy, campbell and pekin ducks; the total losses averaged 28.50, 31.58 and 38.90 percentages for Muscovy, Campbell and Pekin ducks respectively. The mean per cent eviscerated yields were 71.50, 68.42 and 61.1 respectively in Muscovy, Campbell and Pekin ducks and the

per cent ready-to-cook yields averaged 71.20, 68.40 and 74.20 respectively in Muscovy, Campbell and Pekin ducks.

Narahari *et al.* (1988) studied the processing and cut-up yields of ducks and observed that pre-slaughter weight (g), per cent blood loss, feather loss, giblet and ready-to-cook yields averaged 1189.5 ± 10.4, 6.00 ± 0.068, 6.30 ± 0.35, 7.90 ± 0.14 and 70.04 ± 1.10 respectively.

Gajendran *et al.* (1990) studied carcass characteristics of 72 week-old desi ducks and reported that body weight averaged 1241.1 g. The mean per cent total offal, blood loss, feather loss, giblets and ready-to-cook yields were 21.58, 5.90, 5.04, 7.83 and 73.18 respectively.

Nanda and Sharma (1990) conducted studies on adult desi ducks and found that the mean pre-slaughter weight (g), per cent blood, feather, offal losses, eviscerated and giblet yields averaged 1053.75, 5.72, 4.71, 20.85, 62.67 and 6.05 respectively.

On conducting slaughter studies in khaki Campbell ducks of both sexes at 3, 5, 7, 9 and 11 months of age Reddy and Reddy (1990) reported that the live weight averaged 1488.7 ± 48.20 and 1414.5 ± 32.2 (g) in males and females respectively and per cent ready-to-cook meat yield averaged 70.52 ± 1.89 and 64.48 ± 2.13 in males and females respectively.

Peethambaran (1991) conducted experiments on Pekin ducks and reported that the mean per cent blood, feather, total offal losses, eviscerated, giblet and ready-to-cook yields were 5.52, 4.49, 30.37, 63.93, 6.76 and 69.69 respectively for Pekin ducks aged ten weeks.

In a study conducted in native female ducks Biswas *et al.* (1992) reported that mean per cent feather and giblet were 4.87 and 7.97 respectively.

Wang and Wan (1996) conducted studies on the optimal culling age for laying Tsaiya ducks and reported that the live weight did not differ among the ages of 72, 80, 90 and 100 weeks and the weights of heart, gizzard and liver were not significantly influenced by age between 72 and 100 weeks.

Meat to bone ratio

Narayanankutty *et al.* (1982) reported that the meat to bone ratio averaged 1.72 in crossbred (Khaki Campbell x Desi) female ducks one year old.

Comparing the meat to bone ratio of spent hens Vs spent ducks, Kutty *et al.* (1983) reported that ratio averaged 1.83 and 1.79 respectively.

Romboli (1983) conducted experiments on ducks aged between two weeks to three months and reported that meat to bone ratio reached 2.4 at 70 days of age.

Gajendran *et al.* (1990) studied on the carcass characteristics of desi ducks of 72 weeks of age and reported that the meat to bone ratio averaged 2.39.

Nanda and Sharma (1990) reported that the meat to bone ratios in desi male and female ducks as 1.90 and 1.75 respectively.

Abdominal fat

Feed energy supplied to the birds in excess to their metabolic needs, is stored in the body as fat, a major portion of which is deposited in the abdominal region (Essary *et al.*, 1960 and Macklin and Gordon, 1961).

The nutritional, managemental and other environmental causes and the genetic effects have been observed to be important in determining the deposition of abdominal fat in poultry (Far *et al.*, 1977 and Merkley *et al.*, 1977).

Tai *et al.* (1985) reported that the breed of ducks significantly affected the percentage of abdominal fat deposition, and at nine weeks of age the highest deposition 1.94 per cent was reported in Australian Tegal ducks and the lowest 0.97 per cent in Muscovy x Pekin crosses.

Peethambaran (1991) conducted experiments on Pekin ducks and observed that at five and eight weeks of age, fat deposition was scanty and at tenth week of age fat deposition

ranged from 0.48 to 0.87 per cent with an overall mean of 0.58 per cent.

In a study conducted in native female ducks, Biswas *et al.* (1992) reported that the abdominal fat averaged 0.43 percentage.

Duck meat products and their shelf-life

There are hardly any reports on the preparation of duck meat sticks from deboned minced meat of spent desi ducks. Perusal of available literature on poultry produces technology revealed gaps in our knowledge in respect of many information on new marketable deboned minced poultry meat products which suit to Indian taste.

Various chicken meat products were developed and marketed profitably in the supermarket at Central New York. Baker *et al.* (1967) developed chicken steaks and marketed profitably. Hasiak and Baker (1968) could store the chicken steak well for seven to ten days under refrigeration storage and for three weeks under frozen storage.

Puttarajappa *et al.* (1971) in their studies on shelf-life of tandoori chicken at two temperatures (40°F and 12°F) to simulate the marketing conditions indicated that the shelf-life of the product was about 13 days at 40°F and about 44 days at 12°F without appreciable changes in its quality

characteristics from chemical, microbial and sensory point of view.

Research results indicated the restructuring could make less valuable cuts of meat more palatable (Mandigo, 1975; Chesney *et al.*, 1978 and Seideman *et al.*, 1981).

Poultry sausages have been successfully produced by binders such as dried skim milk, semolina, corn starch and pasteurized egg white (Panda, 1980).

Narayanankutty and Nair (1981) conducted experiments on duck meat products and reported that duck meat could be a dietary substitute for chicken meat.

Seideman *et al.* (1981) conducted studies on restructured steaks prepared from meat of spent fowl and reported that restructured steaks made from raw meat were preferred to restructured steaks made from formulations containing varying percentages of precooked meat. The authors suggested that formulations containing 20 to 50 per cent precooked spent fowl meat could be used in the manufacture of restructured steaks.

Narayanankutty *et al.* (1983) developed chicken steaks using two recipes, from deboned minced meat of spent broiler breeder hens and reported that a highly acceptable product in the form of chicken steak could be prepared. The authors also observed that the optimum condition for its long term storage

was -15°C at which temperature the product could be held upto three months without any quality deterioration.

Studying the effect of storage on the quality of duck sausages, Khanna and Panda (1984) observed that the product could be stored for seven days at 4 ± 1°C and 15 days at -10°C without adversely affecting its organoleptic acceptability.

Kondaiah *et al.* (1988) conducted studies on the utilization of whole meat from spent hens for chicken sausages and found that the product could be stored upto 90 days at -10° without any quality deterioration.

Poultry sausages have been successfully produced by blending chicken meat with vegetables (Panda and Mohapatra, 1989.

Thind *et al.* (1988) conducted studies on chicken patties and observed that patties could be stored upto 60 days without any quality deterioration.

Anjaneyulu *et al.* (1990) conducted studies on quality of patties from chicken, mutton and combination of meats and reported that yield and composition of chicken and mutton patties were not different significantly and that appearance, flavour and overall acceptability of chicken patties were significantly ($P<0.05$) better than the patties of combination of meat which were markedly better than mutton patties.

Reddy (1990) conducted slaughter studies on Khaki Campbell ducks aged between 3 to 11 months and reported that the ready-to-cook carcass could be stored under refrigeration at 4±1°C for 120 hours and frozen condition at -18±1°C for 50 days.

Anand *et al.* (1991) on studying the microbial quality and shelf-life of chicken patties stored at -18°C observed that the chicken patties had a shelf-life of 150 days.

Rejikumar *et al.* (1991) conducted studies on chicken meat balls and reported that a highly acceptable chicken meat product in the form of chicken meat balls could be prepared from deboned minced broiler chicken meat and the optimal condition for its long term storage was determined to be -15°C and that at this temperature the product could be held upto two months without any appreciable quality deterioration.

Sekhon and Bawa (1991) conducted experiments to study the effect of frozen storage and extenders on the quality of meat tikkas from culled hens and observed the tikkas could be stored under frozen condition for four months without any quality deterioration.

Barkataki *et al.* (1994) conducted studies on quail meat patties and reported that a highly accepted quail meat product in the form of quail meat patties could be prepared from deboned minced quail meat. It was also observed that the

product could be held upto two months at -15°C without any qualitative changes or deterioration.

Quality characteristics of poultry meat and its products proximate composition

Harshaw (1942) found that the edible portions of the fowl contained 19.9 per cent protein.

The age, sex and species of poultry besides the parts of the carcass from which meat is taken are reported to influence the fat content considerably (Mecchi *et al.*, 1956).

Scott *et al.* (1957) reported that the duck carcass fat content was negatively correlated and moisture content was positively correlated with the types of feed. The authors also reported that the crude protein in the duck carcass on fresh basis ranged from 12.70 to 14.70 per cent.

Laurie (1966) opined that the quality of any meat depends on its physico-chemical properties, level of protein and fat contents and other chemical constituents present in the meat.

It was reported that the carcasses from young birds have a higher proportion of moisture than that from the older ones (Mountney, 1966).

Studies on the formulation and quality evaluation of chicken sausage were conducted by Majhi (1973) and reported

that the proximate composition of the product viz., moisture, protein, fat and total ash were 65.45, 10.67, 10.67 and 2.97 per cent respectively.

Poultry meat consists of 75 per cent moisture, 18 per cent protein, 3 per cent fat and 0.7 per cent inorganic salts (Varadarajulu, 1973).

Dhillon and Maurer (1975) reported that there was very little, of any difference in the values of protein, fat and other proximate principles of meat stored under frozen condition for extended periods.

Cunningham and Bowers (1977) reported that the chicken patties, the fat content ranged from 11.0 to 13.5 per cent and per cent protein ranged from 18.1 to 20.0. It was also reported that per cent moisture and ash averaged 68.90 and 1.34 respectively.

Studies on qualities of patties were conducted and reported that the per cent mean protein and fat were 21.71 and 5.61 respectively for chicken patties prepared from hand boned minced fowl meat Lyon *et al.* (1978).

Zaniecka and Bobrowska (1981) stated that protein per cent in lean plus skin in male and female Pekin ducks were 17.0 and 16.5 respectively.

Chiang and Brekke (1982) in their studies on chicken strip prepared from raw fowl meat, and reported that the per cent moisture, protein, fat and total ash averaged 60.02, 20.28, 16.37 and 3.25 respectively.

Seideman *et al.* (1982a) conducted studies on restructured steaks prepared from meat of spent fowl and reported that the moisture and fat of raw steaks were 72.00 and 4.58 percentages respectively.

Seideman *et al.* (1982b) reported that the per cent moisture and fat averaged 69.81 and 6.94 respectively for restructured chicken steaks prepared from spent fowl.

Hudsky and Cerveny (1983) slaughtered meat type ducks at 57 days of age, and reported that carcass protein content ranged from 13.67 to 13.85 per cent.

Narayanankutty *et al.* (1983) working on chicken steak reported that proximate composition remained unaltered upto 90 days at -15°C. The per cent moisture, protein, fat and total ash of the product ranged from 58.46 to 59.21, 18.77 to 20.82, 5.79 to 6.33 and 3.25 to 3.58 respectively.

Khanna and Panda (1984) studied the effect of storage on quality of duck sausages and reported that per cent moisture, protein, fat and ash averaged 62.81, 23.35, 10.72 and 2.74 respectively in fresh/unstored product and the values averaged

64.85, 22.60, 10.74 and 3.02 percentages respectively for moisture, protein, fat and ash for the product stored at -10°C upto 30 days. The results of their studies also revealed that values for proximate components were not significantly different from zero day and 30 days of storage at -10°C.

Kriz *et al.* (1984) observed that in three groups of Pekin ducks viz. mixed sexes, males and females, the percentages of moisture in the muscle averaged 72.9, 73.0 and 71.8 and that of protein averaged 18.2, 18.5 and 18.1 respectively at 50 days of age.

Mahapatra *et al.* (1984) in their studies on the acceptability and composition of chicken patties observed that the per cent moisture, protein, fat and ash averaged 49.8, 14.8, 18.3 and 3.3 respectively.

Hollender *et al.* (1987) conducted studies on patties made from restructured spent layer meat and observed that per cent moisture, protein, fat and ash averaged 70.53, 21.75, 9.20 and 0.86 respectively.

Kondaiah *et al.* (1988) carried out studies on chicken sausages prepared from spent hens and found that values averaged 63.10 ± 0.29, 14.70 ± 0.18, 14.60 ± 0.69 and 3.10 ± 0.13 per cent for moisture, protein, fat and ash respectively.

Lyon *et al.* (1988) conducted studies on chicken patties and reported that the per cent moisture, protein and fat averaged 73.08, 18.15 and 6.35 respectively.

Panda and Mohapatra (1989) reported that the per cent moisture, protein and fat contents of raw duck meat at eight weeks of age averaged 52.7, 19.9 and 35.8 respectively.

Anjaneyulu *et al.* (1990) reported that percentage of moisture, protein, fat and ash averaged 60.19 ± 0.36, 13.91 ± 0.57, 19.02 ± 0.76 and 2.74 ± 0.04 respectively in chicken patties.

Reddy and Reddy (1990) reported that the per cent protein and ash of the duck meat averaged 16.2 and 1.0 respectively.

Rejikumar *et al.* (1991) carrying out the storage studies of chicken meat balls under frozen conditions observed that the proximate composition of a product remained unaltered at -15°C upto 60 days. The per cent values for moisture ranged from 71.04 to 72.26 for recipe I and for recipe II from 67.93 to 69.73 percentages, and the protein per cent ranged from 14.00 to 15.21 for recipe I and for recipe II from 12.49 to 14.46 irrespective of days of storage. The per cent fat content of recipes I and II ranged from 5.55 to 5.90 and 5.30 to 5.93 respectively and the total ash ranged from 3.64 to 4.33 and 3.43 to 4.16 percentages respectively.

Sekhon and Bawa (1991) conducted experiments on the quality of meat tikkas prepared from culled hens and reported that per cent moisture, protein and fat averaged 68.89, 13.09 and 6.74 for raw tikkas prepared from culled hens. The per cent moisture, protein and fat were 62.32, 14.20 and 6.85 respectively for poultry tikkas stored for one month and the values for poultry tikkas stored for two months were 67.74, 13.54 and 6.80 respectively.

Bhat (1992) suggested that the best way to cut down fat content of poultry meat is to remove skin, while preparing ready-to-serve or ready-to-cook chicken/duck product, since fat is mostly located under the skin. The author also reported that the duck meat contained 52.8, 16.2, 30.0 and 1.0 percentages respectively of moisture, protein, fat and ash.

Smith *et al.* (1993) conducted studies on 42 weeks old Pekin duck and reported that the per cent moisture, protein, fat and ash averaged 77.70, 19.50, 2.34 and 1.09 respectively.

Barkataki *et al.* (1994) conducted storage studies on quail meat patties under frozen conditions and observed that the proximate components of the products were not influenced by the storage temperature and periods of storage. Irrespective of duration of storage, the per cent moisture, protein, fat, and ash ranged from 71.58± 0.55 to 72.47 ± 0.47, 16.77 ± 0.40 to 17.25 ± 0.55, 5.77 ± 0.17 to 5.99 ± 0.25 and 4.19 ± 0.45 to 4.64 ± 0.11 respectively at -15°C.

Honikel and Klotzer (1996) conducted studies on composition of broiler carcass and reported that the per cent protein, fat and water averaged 19.85, 9.25 and 70.0 respectively.

Nath *et al.* (1996) conducted studies on qualities of chicken patties and the per cent moisture, fat and protein were found to be 62.20 ± 0.28, 11.77 ± 0.24 and 17.81 ± 0.18 respectively.

Rancidity

The 2-thiobarbituric acid number (TBA number) in meat samples offers an indication of rancidity in meat during storage. It has been observed that there is more rapid rate of oxidation of fatty acids in the dark meat than in the white meat. Grinding the meat tended to increase the TBA number (Keskinel *et al.*, 1964).

Baker *et al.* (1967) determined the TBA values of chicken steaks prepared from white and dark meats and stored under different storage conditions over varying periods. The results showed that at refrigeration temperature, the values increased as the number of days of storage increased. Freezing for three days at -15°F prior to refrigeration at 35°F had only a slight advantage so far as TBA values were concerned. The best storage for this product appeared to be at -15°F where less TBA values were recorded.

Hasiak and Baker (1968) have published detailed methodology on the preparation of chicken steaks from the breast and thigh meat. Their findings on the TBA values of market test steaks were fairly close to those of Baker *et al.* (1967). The studies indicated that the product had a shelf-life of seven to ten days under refrigeration storage and at least three weeks in the frozen state.

The mode of deboning the meat had also an effect on the rancidity. Mechanically deboned meat had a higher TBA number than hand deboned meat (Schnell *et al.*, 1971). Froning (1973) observed the TBA values to increase with the storage time even at fairly low temperature (-29°C). However, Dawson (1975) observed that minimum lipid oxidation can be achieved by low temperature preservation. It was assumed by Dawson *et al.* (1975) that the TBA values above two may be associated with the development of rancidity in meat samples.

Lyon *et al.* (1978) reported that TBA values ranged from 0.31 to 0.85 for the chicken patties stored at -40°C upto eight weeks and showed no significant rancidity development.

Chiang and Brekke (1982) in their studies with spent fowl observed TBA numbers of 0.5 at 3.7°C upto three days of storage and a value of 1.2 at the same temperature upto 42 days of storage. Authors also reported a TBA number of 0.62 under frozen storage initially and the same was increased

during first three weeks (1.00) and decreased slightly thereafter (0.90).

Narayankutty *et al.* (1983) conducted storage studies on chicken steaks and observed an increase in TBA numbers with increase in the length of storage time under refrigeration condition (5°C) and at -15°C the steaks remained almost unaffected in respect of TBA numbers. The TBA numbers averaged 0.68, 0.70, 0.72, 0.78, 0.82, 0.96 and 1.19 respectively for zero, 15, 30, 45, 60, 75 and 90 days of storage.

Hollender *et al.* (1987) conducted studies on the quality of patties made from spent layer meat and observed that the TBA values generally increased during storage period of zero to six months. The TBA numbers of chicken patties averaged 0.80, 1.41, 2.10 and 3.21 respectively for zero, one, three and six months of storage.

Sreenivasaiah *et al.* (1988) compared selected quality characteristics of raw and precooked meat of spent hen. The results indicated that the TBA values of precooked meat were higher than that for the raw meat and it was suggested that cooked meat will be acceptable upto eight days under refrigeration and upto two months under frozen conditions.

Reddy (1990) conducted studies on stored duck carcass and reported that the TBA values increased as the period of

storage increased both during refrigeration and frozen storage and the authors suggested that this was due to onset of rancidity in the stored carcasses fat. The TBA values were found to be 0.53 ± 0.08, 1.55 ± 0.14 and 2.13 ± 0.20 for carcasses stored at 0 hours, 25 and 50 days respectively.

Anand *et al.* (1991) studying the microbial quality and shelf-life of chicken patties stored at -18°C observed that the thiobarbituric acid increased from 0.28 to 2.17 mg malonaldehyde/kg during storage (zero to 150 days). The TBA values averaged 0.28 ± 0.07, 0.35 ± 0.04, 0.38 ± 0.02, 0.43 ± 0.01 and 0.42 ± 0.04 respectively for zero, 15, 30, 45 and 50 days of storage.

Rejikumar *et al.* (1991) conducted studies on chicken meat balls under frozen condition and reported that the TBA numbers increased with increase in length of storage. The TBA numbers of chicken meat balls stored at -15°C were reported to range from 0.54 to 1.21 for recipe I and from 0.58 to 1.18 for recipe II.

Barkataki *et al.* (1994) carrying out storage studies on quail meat patties under frozen (-15°C) condition observed that the TBA numbers of quail meat patties ranged from 0.20 ± 0.03 to 0.37 ± 0.01 during zero to 60 days of storage. The TBA values were significantly higher ($P<0.05$) for patties stored for 30, 45 and 60 days at -15°C. The values for the

product stored at -15°C for 30,45 and 60 days were 0.280, 0.32 and 0.37 respectively.

Total bacterial count

It has been a recognised fact that the microbial population of poultry meat prior to or during the storage has a profound implication from the public health point of view.

Shrimpton and Barnes (1960) reported that the microbial load of dressed chicken, packaged in oxygen permiable films went up from $1.5x10^5$/sq.cm to $4.9x10^6$/sq.cm when held at 1°C for 8 days.

Baker *et al.* (1967) prepared chicken steaks from the white and dark meat and determined the total bacterial counts of these products under different storage conditions over varying periods. The results showed that at refrigeration temperature, the total bacterial counts increased as the number of days of storage increased. The authors also reported that the best storage condition for this product appeared to be refrigeration at -15°F where the lowest bacterial counts were recorded.

Hasiak and Baker (1968) also prepared chicken steaks from the breast and thigh meat and their findings with respect to the bacterial count of market test steaks were fairly close to those of Baker *et al.* (1967).

Ostowar and MacNeil (1971) reported a decrease in total bacterial population per gramme at lower storage temperature even with extended storage.

Maxcy *et al.* (1973) in their studies on microbial load of ground poultry meat observed that total viable count ranged from $10x10^4$ to $10x10^5$ per gramme of meat. The authors also found that micro-organisms in frozen products were similar and remained stable during the storage upto seven weeks.

At 0°C or less, most of the organisms in meat failed to grow (Sahoo, 1973). Slow freezing was found to be damaging to microbial population. Pathogenic organisms were reduced in number due to rapid freezing. Repeated freezing and thawing had a drastic killing effect on vegetative forms of microorganisms.

Froning (1976) reviewing the literature on the microbial content of mechanically deboned meat reported the total counts per gramme to range from $3.25x10^5$ to $9.32x10^6$ as the days of storage at 3°C increased from zero to 12. On the contrary, storage at -15°C even for 270 days gave a total count of $2.63x10^3$ per gramme.

Cunningham and Bowers (1977) studied the microbial count and stability of chicken patties held at refrigeration temperature and observed that initial count per gramme was

never greater than 10^4 and total count per gramme ranged from $9x10^3$ to $7x10^6$ after 10 days of storage at 3°C.

Storage conditions and period of storage influenced the microbial loads on poultry carcasses (Panda, 1980).

Panda (1981) stated that development of offlavour in meat tissue starts when the microbial load reaches 10^7 to 10^8/g.

Analysing the samples of whole dressed chicken, boneless leg, boneless breast, liver, gizzard and khema for their total viable count (TVC) (Murugkar *et al.*, 1993) reported that the majority of the product had the total viable count in the range of 4 to 7 log CFU/g. The whole chicken yielded the lowest counts of 5.57 log CFU/g. The mean total viable count of chicken khema was found to be 6.26 log CFU/g with a range of 4.90 to 7.06 log CFU/g.

Narayanankutty *et al.* (1983) carried out storage studies on chicken steaks and observed that the microbial population decreased in samples stored at -15°C. The total bacterial counts averaged $8.83x10^4$, $8.17x10^4$, $7.60x10^4$, $6.65x10^4$, $6.42x10^4$, $6.06x10^4$ and $5.47x10^4$ respectively for zero, 15, 30, 45, 60, 75 and 90 das of storage.

Horokava and Lukacka (1984) found the total counts in the range of log 4 to 6 CFU/g in the deboned poultry meats.

Khanna and Panda (1984) conducted studies on sausage prepared from white Pekin ducks and observed that the product could be stored upto 30 days at -10°C. The total aerobes were $0.9x10^1$ and $1.2x10^1$ respectively for the products at 15 and 30 days of storage. The authors concluded that at the end of storage, the products were found to be within the limits of microbial safety prescribed, with very little change in their composition.

Reddy (1990) reported that the total aerobes (log/cm^2) at 0 hours, 25 days and 50 days averaged 4.05 ± 0.31, 4.16 ± 0.60 and 4.53 ± 0.26 respectively for female duck meat stored at -19±1°C and author also reported the multiplication of psychrophiles was controlled by storage at -18±1°C for 25 days.

Anand *et al.* (1991) carrying out studies on microbial quality of chicken patties stored at -15°C observed a significant increase in bacteria during preparation of patty mix, but the overall count decreased substantially during freezing. The authors also reported that the aerobic counts decreased from 3.71 to 2.62 log/g after 150 days of storage and aerobic plate counts averaged 3.71, 3.78, 3.51, 3.53 and 3.47 respectively for zero, 15, 30, 45 and 60 days of storage.

Rejikumar *et al.* (1991) conducting storage studies on chicken meat balls observed that the total bacterial count reduced significantly ($P<0.05$) with increase in storage time

at -15°C. The microbial population of fresh chicken meat balls (log count/g) were 7.52 and 7.59 for recipes I and II respectively. The authors also reported that the counts were reduced when observed fortnightly upto 60 days of storage. The counts averaged 6.47, 5.94, 5.54 and 5.37 for 15, 30, 45 and 60 days of storage periods respectively at -15°C for the recipe I and for the recipe II the values averaged 6.23, 6.13, 5.23 and 5.05 respectively for the above periods.

Sekhon and Bawa (1991) prepared meat tikkas from the culled hens and determined the total bacterial counts of these products under fresh and deep freezing stroage condition over varying periods. The results showed that the fresh, the total bacterial count averaged 2.78×10^3 in fresh product and under deep freezing condition for one month and two month storage periods, the counts averaged 1.85×10^3 and 2.08×10^3 respectively.

Barkataki *et al.* (1994) conducted research work on quail meat patties and observed that the total bacterial counts reduced considerably at -15°C and the reduction was found to be significant ($P<0.05$), and the total bacterial count (colony forming units/g) of quail meat patties was 7.80×10^5 for the fresh samples. The counts were found to be reduced when observed fortnightly upto 60 days of storage and on 60th day, the value was 1.91×10^3. It was concluded that the bacterial load was influenced by temperature (-15°C) and duration of

storage and the difference in total bacterial count between zero and any other days of storage were significant statistically ($P<0.05$).

Organoleptic evaluation of duck meat stick

Mouth feel is affected by firmness, softness, tenderness, and juiciness (Amerine *et al.*, 1965).

Baker *et al.* (1969) found that as the level of fat in the formula was raised, the frankfurters became less tender when unheated but more tender when tested hot.

Dawson (1970) found that the addition of fat to fresh turkey sausages dramatically increased the acceptability.

Kramer and Twigg (1970) found that mouth feel was affected by firmness, softness, tenderness and juiciness.

Varadarajulu and Cunningham (1971) did not find any differences among sexes and type of muscles in respect of tenderness scores of turkey carcasses.

Advantages claimed of flaking meat for restructure products included improved texture, retention of natural juices (less drip loss), better binding and cohesive properties, reduced cooking losses, improved sensory characteristics (acceptability of colour, flavour, juiciness,

tenderness) and elimination of pellets of gristle and connective tissue (Ferren, 1972).

Mandigo (1975) reported that attributes such as mouth feel, juiciness, and bind of the product could be regulated through product formulation and processing.

Baker and Darfler (1977) stated that the tenderness was not affected by storage periods.

Huffman (1979) reported that the challenge to the meat industry was not produce an engineered steak or chop that would bind satisfactorily until cooked and that had the desired sensory properties.

Ahmed *et al.* (1984) conducted studies on ducks and observed that tenderness scores were not influenced by the sex, and they also reported that juiciness scores and flavour scores were not affected by different storage condition.

Narayanankutty and Nair (1981) conducted preliminary studies and the acceptability of duck meat products and found that there was no difference in the acceptability score obtained from steaks prepared from chicken and duck meats, and authors concluded that duck meat could be a dietary substitute for a chicken meat.

Narayanankutty *et al.* (1983) conducted storage studies on chicken steaks and reported that steaks prepared from deboned

minced meat of spent hen were accepted. The scores for juiciness, tenderness, flavour and overall acceptablity were superior.

Khanna and Panda (1984) conducted storage studies on duck sausage and reported that there was slight decline in the scoring with respect to all organoleptic characteristics, storage at -10°C for 30 days the values were not significantly difference from the score of fresh sausages.

Conducting studies on chicken patties, Thind *et al.* (1988) observed that the organoleptic scores for appearance, colour, texture and overall acceptability showed a gradual decline in quality of patties, but the patties containing upto 30 per cent of giblet were acceptable even after 60 days of storage and the increased level of binder improved overall acceptability.

Reddy (1990) conducted studies on stored duck carcass and recorded that all the organoleptic scores were significantly superior to fresh carcasses and decreased during storage condition and periods. The authors also reported that organoleptic score for tenderness, juiciness and flavour were significantly higher in samples derived from three months aged ducks.

Rejikumar *et al.* (1991) conducted studies on chicken meat balls and observed that the organoleptic evaluation of cooked

chicken meat ball prepared using two recipes and stored at two different temperature for different storage periods revealed that the product prepared by both recipes were equally good and acceptable. The authors also found that irrespective of temperature and storage period, the overall acceptability of chicken meat ball prepared by two different recipes was not found to be different statistically. It was also found that differences in scores for flavour, juiciness and tenderness were not found to be significant statistically between zero and any other days of storage at -15°C.

Barkataki *et al.* (1994) conducted studies on quail meat patties and observed that the scores for flavour, tenderness, juiciness and overall acceptability were not found significantly different at -15°C, irrespective of days of storage.

Cooking loss

Glenn *et al.* (1960) reported that the mean per cent cooking losses varied from 18.8 to 24.9 in chicken broilers.

Snyder and Orr (1964) reported that per cent dripping loss in cooking averaged 24.2 in female Pekin ducks.

Froning (1966) found that wheat gluten significantly reduced cooking loss when added as a binder in poultry meat.

Ashoor and Maurer (1980) conducted studies on the development of a duck roll prepared by fresh-deboned duck meat and skin and indicated that the cooking loss in duck rolls was significantly increased as the levels of skin-fat increased.

The addition of soy protein isolated or textured soy protein increased binding of water and fat, improved adhesion/cohesion and reduced weight losses in sausages (Rogov *et al.*, 1980).

Seideman *et al.* (1981) reported that a decreasing cooking loss per cent was observed with a restructured steaks made to contain the higher concentration of added binders.

Seideman *et al.* (1982a) reported that cooking loss was not significantly affected by formulation, although it did increase as the percentage of precooked meat increased and most of these losses could be attributed to moisture lost during cooking. The authors reported that mean cooking loss averaged 11.70 per cent in raw steaks prepared from meat of spent hens.

Seideman *et al.* (1982b) reported that the mean per cent cooking losses were 13.70 and 10.06 for all meat (controlled) and meat with binder (wheat gluten) respectively.

The per cent cooking loss of cooked duck was reported to be 18 with a range of 15 to 26 (Mountney, 1983).

Thind *et al.* (1988) reported that the cooking loss and shrinkage in size of the patties decreased with the increase in length of storage. The length of storage also reduced the shrinkage but the values at the end of 60 days storage were in the same order as for control. The cooking loss was found to be 18.8 per cent at the end of 60 days of storage. Storage of patties containing 10 per cent binder showed a similar trend with decreased values for both shrinkage as well as cooking loss. The authors also reported that the decrease in cooking loss during storage might be due to the progressive binding of water by the binder. The percentage cooking loss averaged 26.15, 23.33, 21.83 and 20.00 at zero, 15, 30, 45 and 60 days respectively for controlled patties (without binders) and for patties prepared from meat containing binder resulted in cooking loss of 21.86, 17.85, 17.24 and 16.24 at zero, 15, 30, 45 and 60 days respectively.

Sekhon and Bawa (1991) conducted experiments on meat tikkas prepared from spent hens. The mean cooking loss values indicated that their losses were significantly affected by binders and storage. The authors reported that the controlled tikkas from spent hen meat had significantly higher cooking loss (24.71 per cent), followed by potato sample (23.24 per cent) of broiler meat and semolina samples (15.90 per cent) of hen tikkas.

Nath *et al.* (1996) observed that the losses due to cooking were found to be 11.57 and 20.10 per cent respectively for microwave and hot air oven cooked patties.

Materials and Methods

MATERIALS AND METHODS

An experiment was designed and conducted in the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy to examine the feasibility of preparing duck meat sticks from deboned minced meat of spent duck and to evaluate the nutritional characteristics and shelf life of the product.

Desi ducks aged two years were used in the study. Data on processing yields, losses and meat to bone ratio were collected from 10 spent ducks. Deboned minced meat from these ducks were used for the preparation of meat sticks.

Processing yields and losses

The spent ducks were slaughtered and processed as per procedure described by Bureau of Indian Standards (ISI, 1973). Feathers were removed manually. Processing yields and losses were determined.

Meat to bone ratio

From eviscerated carcass, meat was separated from bone mannually and weighed separately. The meat to bone ratio was arrived at using the formula,

$$M:B = \frac{\text{Weight of meat}}{\text{Weight of bone}}$$

Abdominal fat

Estimation of abdominal fat was carried out as per the procedure described by Sadijadi and Becker (1980).

Preparation of duck meat sticks

Deboned minced meat from the spent ducks was used for the preparation of duck meat sticks. Two recipes to suit Indian dietary taste were developed for the duck meat sticks (Table 1)

All the ingredients excluding the batter mixture were mixed thoroughly with minced meat for 2-3 minutes. Then the mixture was spread to a uniform thickness on a tray and was divided into rectangular pieces such that each piece weighed 100 g. These pieces were kept in a freezer. After two hours, the pieces were removed from the freezer and battered by dipping first in egg-flour mixture and powdered bread crumbs were sprinkled over it. The sticks were packed in butter paper and stored under deep freezing temperature (-15°C) for further analysis of quality parameters. The testing by a panel for organoleptic evaluation was carried out after deep frying the sticks at 150 to 175°C for 10 to 15 minutes.

Table 1. Duck meat stick - Recipes

Ingredients	Quantity	
	Recipe I	Recipe II
Deboned and minced duck meat (g)	1000	1000
*Spice mixture (g)	25	25
Garlic (minced) (g)	25	25
Ginger (minced) (g)	10	10
Skim milk powder(g)	-	25
Salt	to taste	to taste
Onion (chopped and minced) (g)	50	50
Batter mixture		
Eggs (No.)	4	4
Maida (g)	50	50
Water (ml)	100-200	100-200
Bread crumbs (g)	150	150

* Spices mixture include - clove 1 g, cinnamon 5 g, anise 6 g, black pepper 6 g, capsicum 5 g and cardamom 2 g

The duck meat sticks prepared as per the two recipes were stored in the freezer and were withdrawn at zero, 15, 30, 40, 50 and 60 days of storage. Representative samples in numbers of five from each recipe at each withdrawal period were analysed for the quality parameters.

The samples were analysed for moisture, protein, fat and total ash by AOAC (1980) methods.

Rancidity was evaluated by 2-thiobarbituric acid (TBA) test of Tarladgis *et al.* (1960).

Total bacterial counts were determined by plate count method as described by Cruckshank *et al.* (1975).

The final product was prepared by deep frying at 150-175°C in refined oil for 10-15 minutes and subjected to organoleptic evaluation. A taste panel consisting of five members were selected for the organoleptic evaluation. A seven point hedonic scale for flavour, tenderness, juiciness and overall acceptability was used as the score card for this purpose and it is presented in Table 2.

The loss in weight during cooking was expressed in terms of per cent cooking loss as follows:

$$\text{Percent cooking loss} = \frac{\text{Initial weight-weight after cooking}}{\text{Initial weight}} \times 100$$

Table 2. Score-card used for organoleptic evaluation

Name of the product :

Date of sampling :

Name of the panelist :

Score system used :

Point	Quality	Remarks
7	Excellent	Can think of no improvement
6	Very good	Enjoyed the product, very slight improvement may be made
5	Good	Enjoyed the product, minor improvement desirable
4	Fair	Improvements of important characters desirable
3	Poor	Moderately undesirable
2	Very poor	Highly undesirable
1	Undesirable	Cannot stand the product

Sample No.	Flavour	Juiciness	Tenderness	Overall acceptance

Any additional information desired to be recorded

Signature

The shelf life of the product was studied in terms of oxidative rancidity, total bacterial count, proximate analysis and organoleptic evaluations at each storage period.

The total number of duck meat sticks prepared from one kilogramme of meat was calculated and from this the yield per kilogramme of meat was worked out.

Cost structure of the product was calculated based on the prevailing cost of the meat and other ingredients used for the preparation.

Statistical analysis of the data was carried out according to Snedecor and Cochran (1967).

Results

RESULTS

Results obtained in the present study are described in this section.

Processing yields and losses

The mean live weight at the time of slaughter, mean per cent meat yields and losses and meat to bone ratio obtained during the processing of desi spent ducks used for the study are presented in Table 3 and graphically represented in Fig.1 and 2. The mean live weight of desi spent ducks was 1425.50 ± 28.86 g at the time of slaughter. The mean per cent eviscerated, giblet and ready-to-cook yields were 60.87 ± 0.30, 9.44 ± 0.25 and 70.94 ± 0.40 respectively. The mean per cent total loss was found to be 29.06 ± 0.40. The components of losses were sub-divided as loss of blood, feathers and inedible offal and the mean per cent contribution of these were 4.36 ± 0.24, 7.76 ± 0.32 and 16.94 ± 0.40 respectively.

Meat to bone ratio

The mean yield of meat was 620.65 ± 0.22 g (71.19 per cent) and bone was 251.15 ± 0.19 g (28.81 per cent) resulting in a meat to bone ratio of 2.47 ± 0.02 (Table 3). The mean per cent component yields of meat and bone of eviscerated desi spent ducks are diagramatically represented in Fig.3.

Table 3. Mean per cent meat yields, losses and meat to bone ratio of desi spent ducks

Mean live weight at the time of slaughter (g)	1425.50 ± 28.86
Eviscerated yield	60.87 ± 0.30
Giblet yield	9.44 ± 0.25
Abdominal fat	0.63 ± 0.02
Ready-to-cook yield	70.94 ± 0.40
Blood loss	4.36 ± 0.24
Feather loss	7.76 ± 0.32
Inedible offal	16.94 ± 0.40
Total loss	29.06 ± 0.40
Meat to bone ratio	2.47 ± 0.02

THE INEDIBLE LOSS IN DESI SPENT DUCK

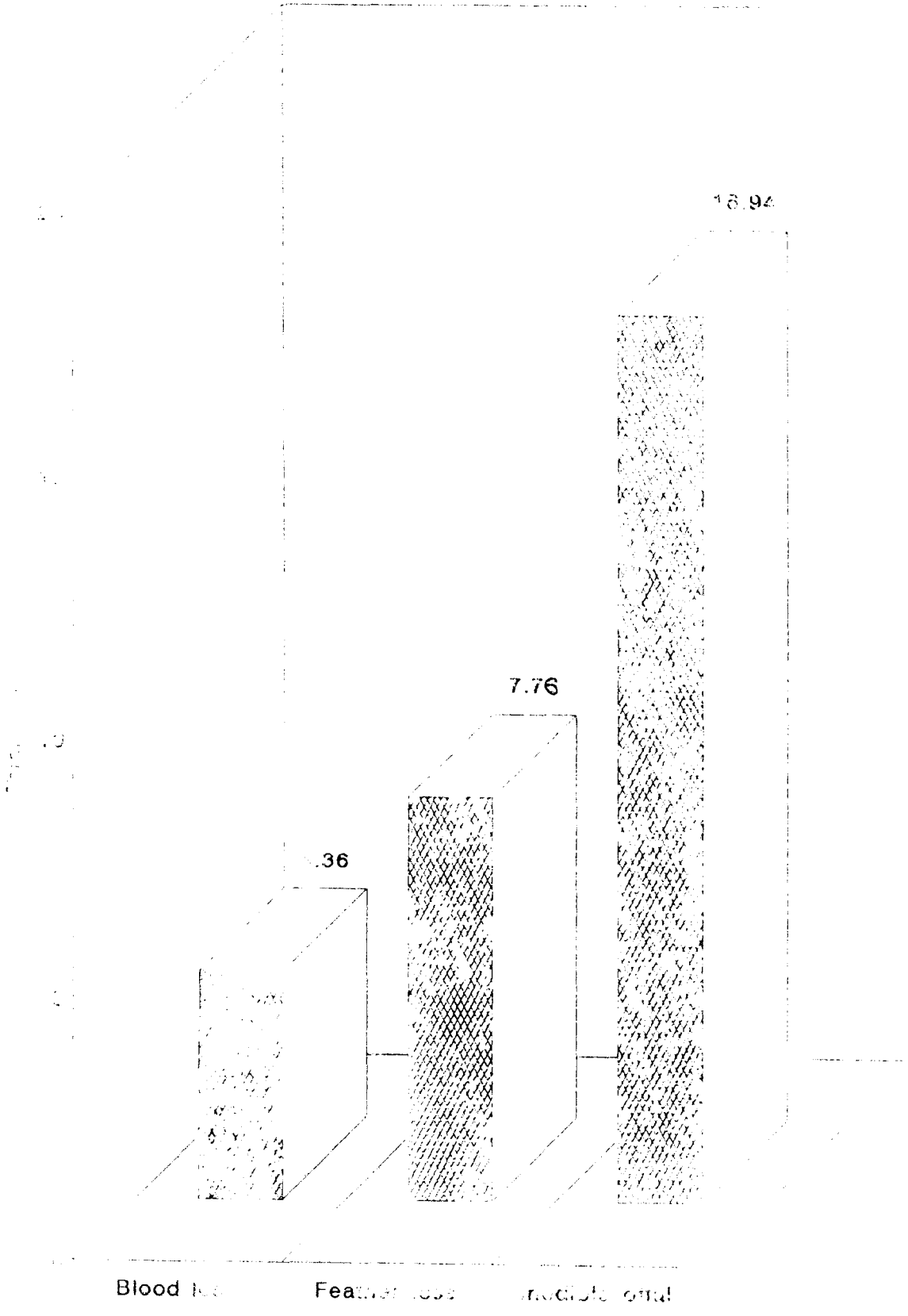


Fig.2 READY-TO-COOK YIELD IN DESI SPENT DUCK

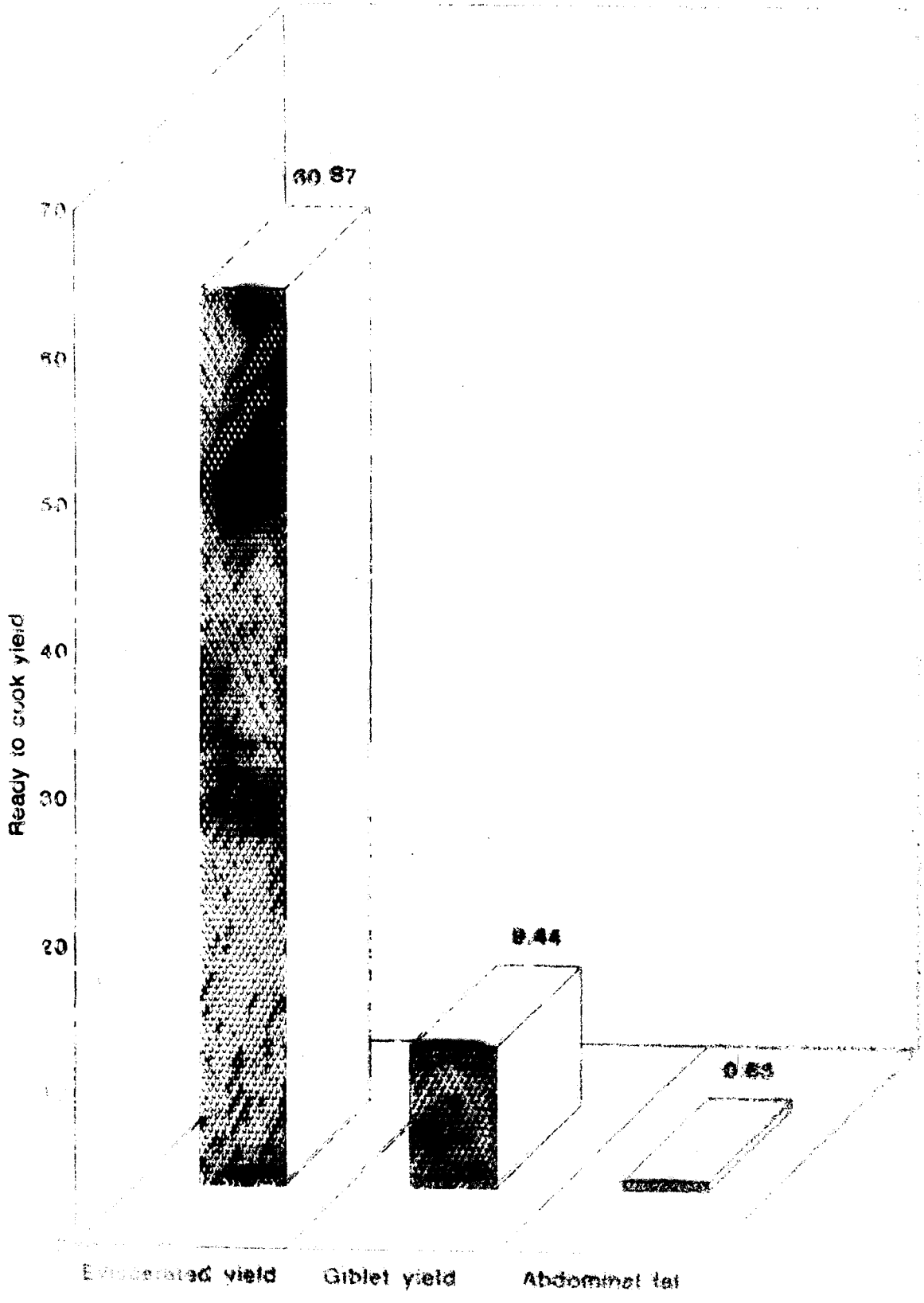


FIG. 2 READY-TO-COOK YIELD IN DESI SPENT DUCK

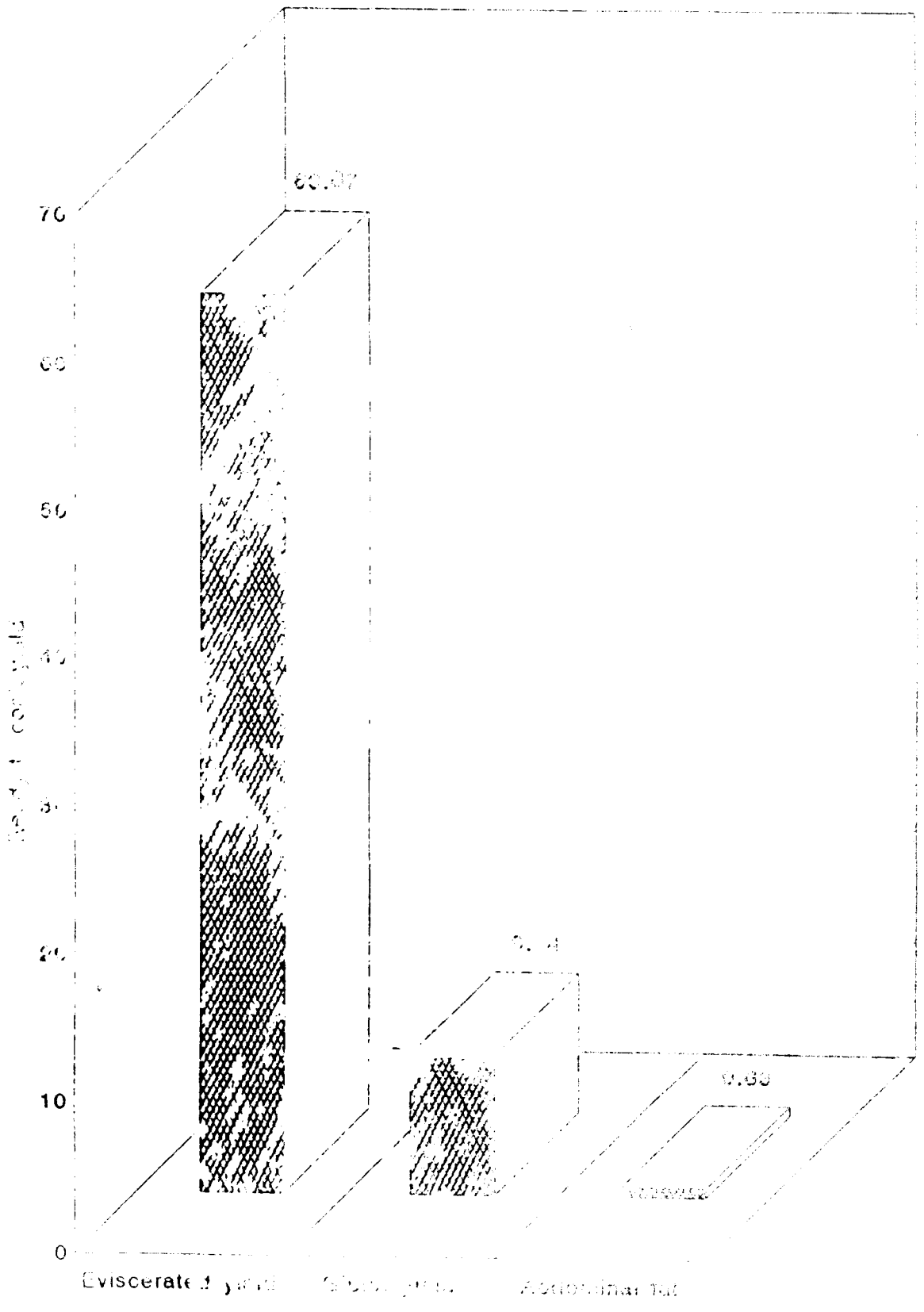
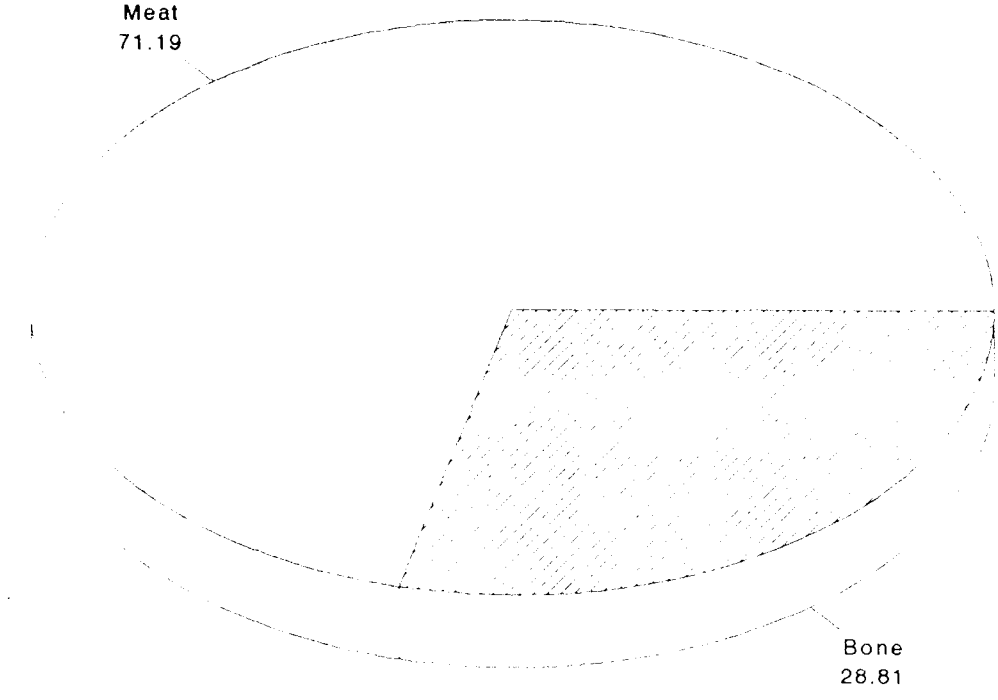


Fig.3 PERCENT MEAN COMPONENT YIELD OF MEAT AND BONE OF EVISCERATED DESI SPENT DUCK



Abdominal fat

The mean per cent abdominal fat deposition was found to be 0.63 ± 0.02 (Table 3).

Preparation and storage of duck meat sticks

Duck meat sticks were prepared from deboned minced duck meat as per two recipes (Table 1). The product was kept at -15°C for zero, 15, 30, 40, 50 and 60 days of storage. Samples were analysed qualitatively and organoleptically at different periods of storage.

Quality characteristics and shelf-life of duck meat sticks

Proximate composition

The moisture, protein, fat and total ash contents of duck meat sticks prepared using two recipes and stored at -15°C for zero, 15, 30, 40, 50 and 60 days were determined (Table 4). The proximate composition of ready-to-cook duck meat sticks prepared as per two recipes were not significantly affected either by storage time or temperature. Irrespective of the duration of storage, per cent moisture was ranged from 71.90 ± 0.05 to 71.94 ± 0.04 for the recipe I. For recipe II the values were ranged from 71.90 ± 0.05 to 71.94 ± 0.05 per cent.

The mean per cent protein content ranged from 18.01 ± 0.02 to 18.03 ± 0.02 and from 18.00 ± 0.02 to 18.04 ± 0.08 for

Fig.1 THE INEDIBLE LOSS IN DESI SPENT DUCK

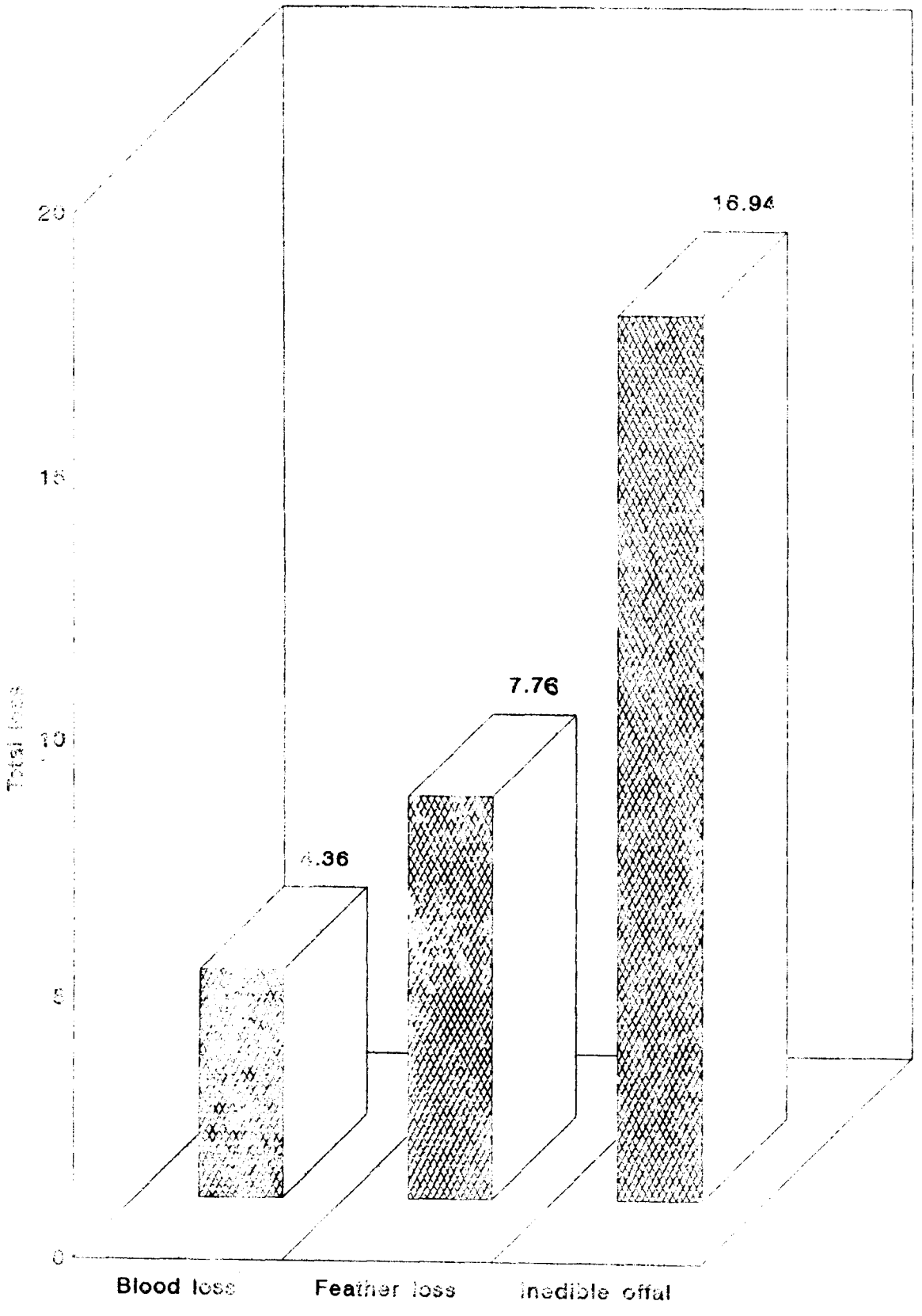


Fig.2 READY-TO-COOK YIELD IN DESI SPENT DUCK

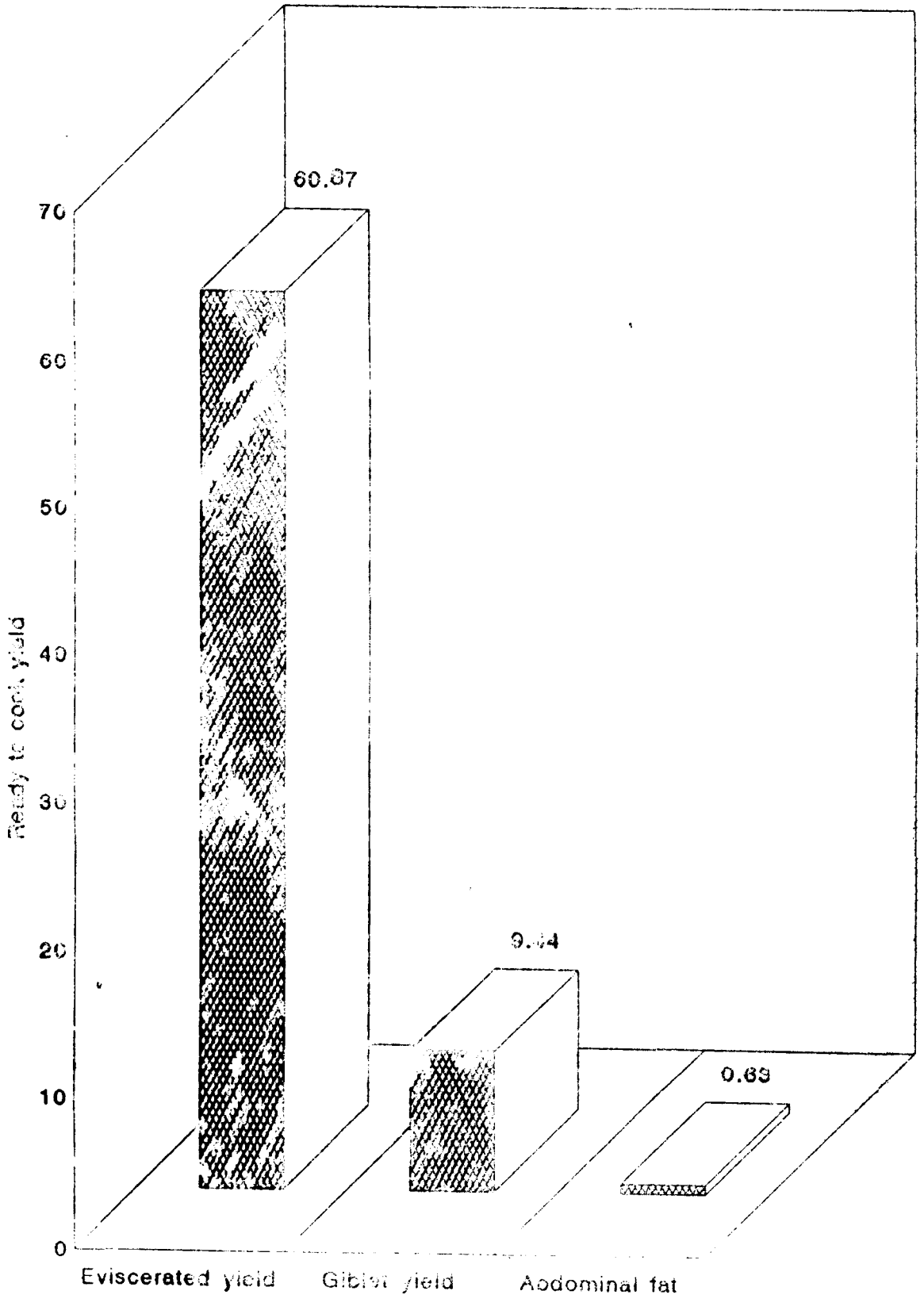
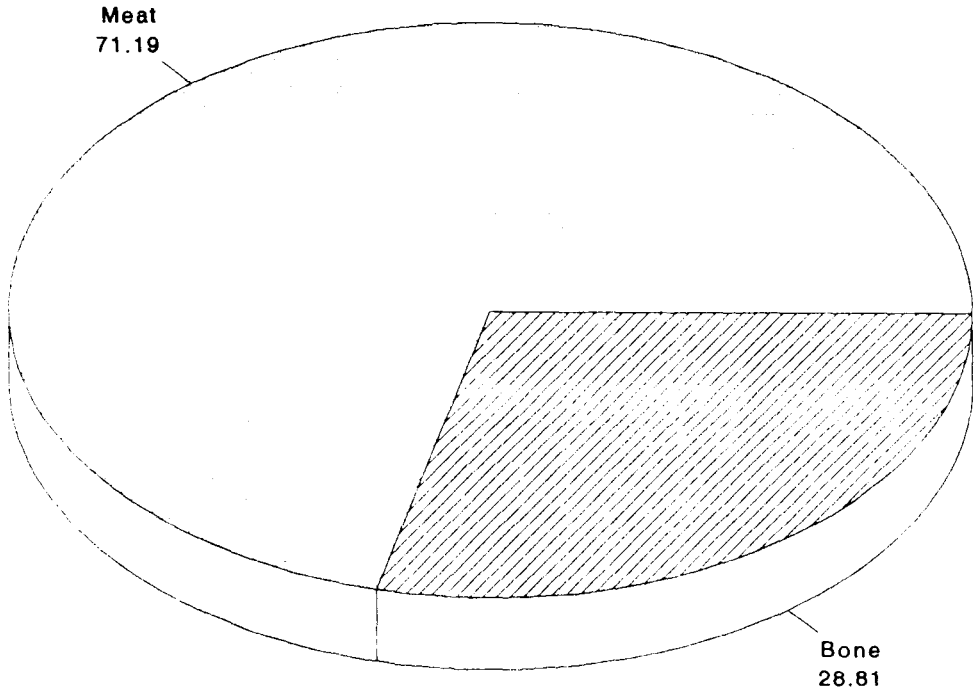


Fig.3 PERCENT MEAN COMPONENT YIELD OF MEAT AND BONE OF EVISCERATED DESI SPENT DUCK



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The mean per cent protein content ranged from 18.01 ± 0.02 to 18.03 ± 0.02 and from 18.00 ± 0.02 to 18.04 ± 0.08 for

Table 4. Influence of freezing temperature (-15°C) and duration of storage on the proximate composition of ready-to-cook duck meat sticks

Days of storage	Moisture (%)		Protein (%)		Fat (%)		Total ash (%)	
	Recipe I	Recipe II	Recipe I	Recipe II	Recipe I	Recipe II	Recipe I	Recipe II
0	71.94± 0.03	71.94± 0.05	18.03± 0.02	18.00± 0.02	5.86± 0.02	5.86± 0.10	3.88± 0.06	3.93± 0.02
15	71.93± 0.04	71.94± 0.05	18.02± 0.04	18.04± 0.08	5.85± 0.03	5.84± 0.02	3.91± 0.04	3.96± 0.04
30	71.94± 0.03	71.92± 0.04	18.01± 0.02	18.02± 0.02	5.86± 0.02	5.86± 0.03	3.90± 0.02	3.90± 0.02
40	71.90± 0.02	71.90± 0.02	18.02± 0.02	18.01± 0.02	5.87± 0.02	5.89± 0.03	3.91± 0.02	3.91± 0.03
50	71.94± 0.04	71.94± 0.05	18.01± 0.02	18.02± 0.02	5.83± 0.02	5.86± 0.03	3.97± 0.02	3.97± 0.02
60	71.91± 0.04	71.93± 0.04	18.01± 0.04	18.02± 0.02	5.84± 0.02	5.85± 0.02	3.94± 0.03	3.95± 0.04

recipes I and II respectively at -15°C irrespective of days of storage.

The mean per cent fat ranged from 5.83 ± 0.02 to 5.87 ± 0.07 and from 5.84 ± 0.02 to 5.89 ± 0.03 for recipes I and II respectively under different duration of storage.

Irrespective of the days of storage, total ash ranged from 3.88 ± 0.06 to 3.97 ± 0.02 and from 3.90 ± 0.02 to 3.97 ± 0.02 for recipes I and II respectively under frozen condition.

Rancidity

The oxidative rancidity of fat in terms of mg malonaldehyde per kg of sample prepared as per the recipes and stored at a temperature of -15°C for varying periods was determined and is presented in Table 5.

The TBA numbers of duck meat sticks prepared as per recipe I ranged from 0.16 ± 0.01 to 0.30 ± 0.01 from zero to 60 days of storage and that for recipe II ranged from 0.17 ± 0.01 to 0.31 ± 0.01 at -15°C from zero to 60 days of storage respectively. Irrespective of the recipes, the differences in the TBA numbers between zero and any other days of storage were found to be significant ($P<0.05$).

Table 5. Influence of duration of storage at freezing temperature of -15°C on oxidative rancidity of duck meat sticks

Days of storage	TBA number (mg malonaldehyde/kg sample)	
	Recipe I	Recipe II
0	0.16 ± 0.01[a]	0.17 ± 0.01[a]
15	0.19 ± 0.01[b]	0.19 ± 0.01[b]
30	0.28 ± 0.01[b]	0.24 ± 0.01[b]
40	0.27 ± 0.01[b]	0.24 ± 0.01[b]
50	0.28 ± 0.01[b]	0.27 ± 0.01[b]
60	0.30 ± 0.01[b]	0.31 ± 0.01[b]

Note: Values bearing the same superscripts within the column between zero day and any other days of storage are not significantly different ($P<0.05$)

Total bacterial count

The total bacterial count of duck meat stick prepared according to the two recipes and stored at -15°C temperature and periods is presented in Table 6.

The total bacterial load of the frozen (-15°C) product reduced considerably with duration of storage and the reduction was found to be significant statistically ($P<0.05$).

The total bacterial counts (expressed as colony forming unit/g) of duck meat sticks stored at -15°C was 1.18×10^5 and 1.25×10^5 for recipes I and II respectively, for the fresh samples. The bacterial counts were found to be reduced during the periods of storage from zero to 60 days. On 60th day the values were 2.42×10^3 and 2.63×10^3 for recipes I and II.

Irrespective of recipes the bacterial load was influenced by duration of storage at -15°C and the differences in total between zero and any other days of storage were significant statistically ($P<0.05$).

Organoleptic evaluation of duck meat sticks

The organoleptic evaluation of ready-to-eat duck meat sticks prepared using the two recipes was conducted by the taste panel and the evaluation scores are shown in Table 7.

Table 6. Influence of freezing temperature (-15°C) and duration of storage on the total bacterial counts of duck meat sticks

Days of storage	Total bacterial count (C.F.U./g of sample)	
	Recipe I	Recipe II
0	$1.18 \times 10^5 \pm 7.15 \times 10^2$ [a]	$1.25 \times 10^5 \pm 7.15 \times 10^2$ [a]
15	$1.88 \times 10^4 \pm 8.94 \times 10^1$ [b]	$1.02 \times 10^4 \pm 4.91 \times 10^1$ [b]
30	$1.30 \times 10^4 \pm 4.91 \times 10^1$ [b]	$1.03 \times 10^4 \pm 1.16 \times 10^2$ [b]
40	$2.83 \times 10^3 \pm 3.84 \times 10^1$ [b]	$1.71 \times 10^3 \pm 2.50 \times 10^1$ [b]
50	$2.40 \times 10^3 \pm 8.04 \times 10^1$ [b]	$2.34 \times 10^3 \pm 1.43 \times 10^1$ [b]
60	$2.42 \times 10^3 \pm 9.32 \times 10^1$ [b]	$2.63 \times 10^3 \pm 8.49 \times 10^1$ [b]

Note: Values bearing the same superscripts within the column between zero day and any other days of storage are not significantly different ($P<0.05$)

The flavour scores of the duck meat sticks prepared as per recipes I and II were not found to be different significantly, irrespective of the days of storage at -15°C. The scores for the freshly prepared duck meat sticks were 5.40 ± 0.25 and 5.60 ± 0.25 for recipes I and II respectively. The scores ranged from 5.40 ± 0.25 to 5.80 ± 0.20 and 5.40 ± 0.25 to 6.00 ± 0.20 respectively for recipes I and II.

The differences in the scores for juiciness of the product were not found to be statistically significant between zero and any other days of storage at -15°C for both the recipes. Scores of the freshly prepared duck meat sticks were 5.60 ± 0.25 and 5.40 ± 0.25 for recipes I and II respectively. The scores varied from 5.20 ± 0.20 to 5.60 ± 0.25 and 5.20 ± 0.20 to 5.40 ± 0.40 for recipes I and II respectively with irrespective of days of storage.

The differences in the scores for tenderness of the product prepared as per recipes I and II and stored at -15°C were not significant statistically, irrespective of the duration of storage. For freshly cooked samples, values for tenderness were 5.40 ± 0.25 and 5.20 ± 0.20 for recipes I and II respectively and the values ranged from 5.20 ± 0.20 to 5.60 ± 0.25 and 5.20 ± 0.20 to 5.40 ± 0.40 respectively for recipes I and II.

The overall acceptability of the duck meat sticks prepared by both the recipes were not significant

Table 7. Organoleptic scores of cooked duck meat sticks as influenced by recipes and period of storage at -15°C

Days of storage	Flavour		Juiciness		Tenderness		Overall acceptability	
	Recipe I	Recipe II	Recipe I	Recipe II	Recipe I	Recipe II	Recipe I	Recipe II
0	5.40± 0.25	5.60± 0.25	5.60± 0.25	5.40± 0.25	5.40± 0.51	5.20± 0.20	5.40± 0.25	5.40± 0.25
15	5.60± 0.40	5.40± 0.25	5.40± 0.25	5.40± 0.40	5.20± 0.20	5.40± 0.40	5.40± 0.25	5.60± 0.25
30	5.40± 0.25	5.60± 0.25	5.40± 0.32	5.20± 0.20	5.60± 0.25	5.20± 0.20	5.40± 0.25	5.20± 0.20
40	5.40± 0.32	5.40± 0.32	5.20± 0.32	5.40± 0.25	5.40± 0.32	5.20± 0.20	5.20± 0.20	5.20± 0.20
50	5.60± 0.25	6.00± 0.20	5.20± 0.20	5.40± 0.32	5.20± 0.20	5.40± 0.32	5.40± 0.25	5.20± 0.20
60	5.80± 0.20	5.60± 0.25	5.40± 0.20	5.20± 0.20	5.20± 0.32	5.40± 0.32	5.40± 0.32	5.60± 0.25

statistically at -15°C, irrespective of the duration of storage. The scores for overall acceptability for the freshly prepared samples were 5.40 ± 0.25 and 5.40 ± 0.25 respectively for recipes I and II. The values ranged from 5.20 ± 0.20 to 5.40 ± 0.32 and 5.20 ± 0.20 to 5.60 ± 0.25 respectively for recipes I and II with irrespective of days of storage.

The scores for flavour, juiciness, tenderness and overall acceptability were not found to be significantly found at -15°C irrespective of days of storage and between recipes.

Cooking loss

The mean per cent cooking loss of duck meat sticks prepared as per two recipes and stored at -15°C for varying period was determined is presented in Table 8. The mean per cent cooking loss of duck meat stick prepared as per recipes I and II were 19.45 ± 0.06 and 19.91 ± 0.07 respectively for fresh samples. The values ranged from 17.97 ± 0.06 to 19.45 ± 0.06 and 18.05 ± 0.07 to 19.91 ± 0.07 respectively for recipes I and II with irrespectively of days of storage. The differences in cooking loss between zero and any other days of storage were found to be significant ($P<0.05$).

Shelf-life of duck meat sticks

From the above observation it was found that duck meat sticks prepared as per two different recipes be stored well

Table 8. Influence of duration of storage at freezing temperature of -15°C on cooking loss of duck meat sticks

Days of storage	Recipe I	Recipe II
0	19.45 ± 0.06[a]	19.91 ± 0.07[a]
15	18.33 ± 0.06[b]	18.51 ± 0.07[b]
30	18.74 ± 0.06[b]	18.82 ± 0.07[b]
40	18.01 ± 0.06[b]	18.63 ± 0.07[b]
50	17.97 ± 0.06[b]	18.07 ± 0.07[b]
60	18.02 ± 0.06[b]	18.05 ± 0.07[b]

Note: Values bearing the same superscripts within the column between zero day and any other days of storage are not significantly different ($P<0.05$)

for upto 60 days at -15°C without causing any quality deterioration.

Yield per gramme of meat

The number of duck meat sticks prepared from one kg of deboned duck meat for recipes I and II was worked out. From each kg of deboned minced meat, 15.25 duck meat sticks of 100 g each could be prepared from recipe I and from recipe II, 15.50 duck meat sticks could be made.

Cost structure of ready-to-cook duck meat sticks

The cost structure for the preparation of ready-to-cook duck meat sticks by the two recipes was calculated and presented in Table 9. The calculation was based on the costs of deboned duck meat and total additives. According to this, the cost of one duck meat stick was Rs.5.63 for recipe I and Rs.5.73 for recipe II.

Table 9. Calculation of cost structure of duck meat sticks prepared as per two recipes

Ingredients	Recipe I		Recipe II	
	Weight (g)	Cost (Rs.)	Weight (g)	Cost (Rs.)
Deboned duck meat	1000	69.00	1000	69.00
Total additives	525	16.89	550	19.74
Total	1525	85.89	1550	88.74
One meat stick	100	5.63	100	5.73

Discussion

DISCUSSION

The results of the study conducted with desi spent ducks to determine the feasibility of using deboned duck meat for the preparation of duck meat sticks, its various characteristics and shelf-life are discussed.

The mean per cent eviscerated, giblet and ready-to-cook yields of desi spent ducks used for the study were 60.87 ± 0.30, 9.44 ± 0.25 and 70.94 ± 0.40 respectively (Table 3).

Body conformation of bird (Jaap and Penquite, 1938); the previous nutritional status of the bird (Harkin *et al.*, 1960) and sex, age, strain (Fry *et al.*, 1962) are known to influence yield percentage.

Snyder and Orr (1964) reported that per cent ready-to-cook and giblet yields averaged 70.3 and 5.5 respectively in eight weeks old pekin ducks. Varadarajulu and Rao (1976) reported that the percentage of carcass yield of desi ducks to be 60.40 and 58.80 respectively in males and females. George *et al.* (1980) conducted experiments on nine week old desi ducks and reported that the percentage of ready-to-cook and giblet yield averaged 69.21 and 6.98 respectively. Narayanankutty *et al.* (1982) studying the processing yields in one year old crossbred female ducks reported that the per cent

ready-to-cook and giblet yield averaged 68.27 and 6.55 respectively. Kutty *et al.* (1983) conducted studies on 18 months old Khaki Campbell ducks and reported that ready-to-cook and eviscerated yields averaged 69.0 and 61.76 per cent respectively. Sahoo and Panda (1983) conducted experiments on one year old Minikos female ducks and reported that per cent dressed and giblet yields ranged from 60.8 ± 3.2 to 67.6 ± 0.9 and 5.18 to 7.80 respectively. Ahmed *et al.* (1984) conducted slaughter studies on female Khaki Campbell ducks 12 months old and reported that chilled carcass and giblet yields averaged 61.17 and 7.03 per cent respectively. Narahari *et al.* (1988) reported that per cent ready-to-cook and giblet yields averaged 70.04 ± 1.10 and 7.90 ± 0.14 respectively. Gajendran *et al.* (1990) reported that giblet and ready-to-cook yields of desi ducks averaged 7.83 and 73.18 per cent respectively. Nanda and Sharma (1990) reported that giblet and eviscerated yield of desi ducks averaged 6.05 and 62.67 per cent respectively. On conducting slaughter studies in Khaki Campbell ducks of both sexes 3, 5, 7, 9 and 11 months of age Reddy and Reddy (1990) reported that the per cent ready-to-cook meat yield averaged 70.52 ± 1.89 and 64.48 ± 2.13 in males and females respectively. Peethambaran (1991) reported that giblet and ready-to-cook yields of ten weeks old Pekin ducks averaged 6.76 and 69.69 per cent respectively. The findings of the present study are fairly in agreement with that of the above authors.

The mean per cent losses of blood, feathers, inedible offal and total loss were also determined during the processing of desi spent ducks (Table 3). The mean per cent losses due to the blood (4.36 ± 0.24), feathers (7.76 ± 0.32), inedible offal (16.94 ± 0.40) and total loss (29.06 ± 0.40) obtained in this study are within the range reported in the literature. Broadbent and Bean (1952) reported that the per cent eviscerated loss of nine weeks old Pekin ducklings was 10.56. George *et al.* (1980) conducted experiments on desi ducks of nine weeks of age old and reported that the mean per cent losses of blood, feather and viscera were 7.27, 8.25 and 8.35 respectively. Loss due to blood generally among ranged from 3.3 to 4.8 per cent and feathers from 4.8 to 8.5 per cent of the total carcass weight (Mountney, 1983). Sahoo and Panda (1983) conducted an experiment on Minikos female ducks of one year of age and reported that mean per cent loss of blood, feather and total inedible, ranged from 5.03 to 6.46, 3.98 to 7.59 and 32.31 to 39.63 respectively. Brahma *et al.* (1985) conducted studies on spent Indian Runner ducks and reported that the per cent loss of blood and feathers averaged 4.93 and 12.42 respectively. Rao and Bulbule (1987) reported that the mean per cent losses due to blood and feather were 3.49 and 6.88 respectively and the authors also reported that the total loss was 28.50 per cent in Muscovy ducks. Narahari *et al.* (1988) reported that per cent blood and feather losses were 6.00 ± 0.068 and 6.30 ± 0.35 respectively. Gajendran *et al.* (1990) reported that in desi ducks per cent loss of blood,

feather and total offal averaged 5.90, 5.04 and 21.58 respectively. Nanda and Sharma (1990) conducted studies on adult desi ducks and reported that per cent losses due to blood, feather and offal were 5.72, 4.71 and 20.85 respectively. Peethambaran (1991) reported that mean per cent losses of blood, feather and total offal were 5.52, 4.49 and 30.37 respectively for ten weeks old pekin ducks.

The values obtained in the present study for blood, feather and inedible offal are fairly in agreement with those reported by the above authors incidating that the processing losses in spent ducks are not much different from that of meaty type of ducks.

Meat to bone ratio

The meat to bone ratio obtained in this study averaged 2.47 ± 0.02 (Table 3). Romboli (1983) reported that meat to bone ratio of duck averaged 2.40 at 70 days of age. The value obtained in the present study for the meat to bone ratio is in close agreement with that reported (2.39) by Gajendran *et al.* (1990) for the desi ducks slaughtered at 72 weeks of age. The values obtained in this study were higher than those reported (1.79) by Kutty *et al.* (1983) for spent ducks.

Abdominal fat

The abdominal fat per cent obtained in this study averaged 0.63 ± 0.02. Tai *et al.* (1985) reported that nine week old Australian Tegal ducks of Pekin crosses had 0.97 per cent abdominal fat. Biswas *et al.* (1992) reported that the abdominal fat averaged 0.43 per cent in native female ducks. The values obtained in this study for the abdominal fat are in agreement with that reported by Tai *et al.* (1985), Peethambaran (1991) and Biswas *et al.* (1992).

Quality characteristics of duck meat sticks

Proximate composition

The proximate analysis of duck meat sticks prepared as per two recipes revealed that per cent moisture ranged from 71.90 ± 0.05 to 71.94 ± 0.04 for recipe I and 71.90 ± 0.05 to 71.94 ± 0.05 for recipe II, protein from 18.01 ± 0.02 to 18.03 ± 0.02 for recipe I and 18.00 ± 0.02 to 18.04 ± 0.08 for recipe II, fat from 5.83 ± 0.02 to 5.87 ± 0.02 for recipe I and 5.84 ± 0.02 to 5.89 ± 0.03 for recipe II and total ash ranged from 3.88 ± 0.06 to 3.97 ± 0.02 for recipe I and 3.90 ± 0.02 to 3.97 ± 0.02 for recipe II (Table 4). These values are almost in agreement with those reported by Varadarajulu (1973) for poultry meat, Cunningham and Bowers (1977) for chicken patties, Seideman *et al.* (1982a) for chicken steak, Narayanankutty *et al.* (1983) for chicken steak, Khanna and Panda (1984) for duck sausage, Kriz *et al.* (1984) for duck

meat, Rejikumar *et al.* (1991) for chicken meat balls and Barkataki *et al.* (1994) for quail meat patties.

Rancidity

The thiobarbituric acid (TBA) numbers of duck meat sticks ranged from 0.16 ± 0.01 to 0.30 ± 0.01 for recipe I and from 0.17 ± 0.01 to 0.31 ± 0.01 for recipe II at -15°C (Table 5). An increase in TBA number was observed with increase in duration of storage for both recipes under frozen storage. The statistical analysis revealed that the TBA number of duck meat stick was influenced by storage periods of -15°C and difference in TBA numbers between zero and any other days of storage was statistically significant ($P<0.05$). The present findings however, indicated that even at fairly low temperature (-15°C) the fat in the meat product was not totally resistant to oxidative rancidity as evidenced by increased TBA number.

Keskinel *et al.* (1964) observed a similar effect of storage on the fatty oxidation in minced meat. Schnell *et al.* (1971) observed mechanically deboned meat had a higher TBA number than hand deboned meat. Froning (1973) observed the TBA values to increase with the storage time even at fairly low temperature (-29°C). Dawson (1975) observed that minimum lipid oxidation can be achieved by low temperature preservation. Lyon *et al.* (1978) reported that the TBA values ranged from 0.31 to 0.85 for the chicken patties stored at

-40°C. Narayanankutty *et al.* (1983) observed that in chicken steak the TBA numbers increased with increase in the length of storage at 5°C and at -15°C the chicken steaks remained unaffected with regard to TBA number. Hollender *et al.* (1987) reported that the TBA values of chicken patties generally increased during storage period.

Reddy (1990) observed that on stored duck carcass the TBA values increased as the period of storage increased under frozen condition. The author opined that this was due to onset of rancidity in stored carcass fat. Anand *et al.* (1991) observed that in chicken patties the TBA numbers increased with increase in the length of storage at -18°C. Rejikumar *et al.* (1991) reported that the TBA values, increased with increased storage period under frozen storage in chicken meat balls. Barkataki *et al.* (1994) reported that the TBA values of quail meat patties increased as the period of storage increased under frozen condition.

In the context of the above, it appears that although the TBA number recorded a slight but significant ($P<0.05$) increase at storage temperature of -15°C, there might not be any deterioration in the quality of duck meat sticks upto 60 days so fat as the organoleptic or nutritional aspects are concerned. This appears to be true in view of the fact that TBA number of only above two in considered to be associated with the development of rancidity in meat products (Hasiak and

Baker, 1968 and Dawson *et al.*, 1975). The findings in the present study which indicate an increase in the TBA number during storage agrees with those reported by Keskinal *et al.* (1964), Schnell *et al.* (1971), Froning (1973), Lyon *et al.* (1978), Narayanankutty *et al.* (1983), Hollender *et al.* (1987), Reddy (1990), Anand *et al.* (1991), Rejikumar *et al.* (1991) and Barkataki *et al.* (1994).

Total bacterial count

Storage of duck meat sticks at -15°C influenced the total bacterial count which decreased with increased duration of storage periods. In the present studies the total bacterial count ranged from $2.83x10^3$ to $1.18x10^5$ for recipe I and $2.63x10^3$ to $1.25x10^5$ for recipe II under frozen condition. The decrease in total bacterial count under frozen condition (-15°F) was also reported by Baker *et al.* (1967), Hasiak and Baker (1968), Ostowar and MacNeil (1971), Maxcy *et al.* (1973), Khanna and Panda (1984), Reddy (1990), Anand *et al.* (1991), Rejikumar *et al.* (1991), Sekhon and Bawa (1991), Barkataki *et al.* (1994). The storage temperature (-15°C) studied in the work helped to reduce the bacterial count in the product and thus aided to maintain its quality for longer periods.

The normal range of total bacterial counts of fresh deboned meat was reported to range from $10x10^4$ to $10x10^5$ per gramme of meat (Maxcy *et al.* 1973). A value of $1.18x10^5$ and $1.25x10^5$ C.F.U. per gramme of sample obtained in this study

(Table 6) for total bacterial counts of freshly prepared duck meat sticks is in close agreement with that reported by the above workers.

The trend of the observation of this study is in agreement with those reported by Baker *et al.* (1967), Sahoo (1973), Froning (1976), Narayanankutty *et al.* (1983), Khanna and Panda (1984), Reddy (1990), Anand *et al.* (1991), Rejikumar *et al.* (1991) Sekhon and Bawa (1991) and Barkataki *et al.* (1994).

Organoleptic evaluation of cooked duck meat sticks

The taste panel preferences to the duck meat sticks prepared as per two recipes were evaluated in terms of flavour, juiciness, tenderness and overall acceptability (Table 7).

The flavour, juiciness, tenderness and overall acceptability of duck meat sticks prepared as per the two recipes were not found to be different statistically under frozen condition (-15°C) for varying periods. The differences in flavour, juiciness, tenderness and overall acceptability between recipes were also not found to be significantly statistically. The scores for flavour, juiciness, tenderness and overall acceptability ranged from 5.40 ± 0.25 to 5.80 ± 0.20, 5.20 ± 0.20 to 5.60 ± 0.25, 5.20 ± 0.20 to 5.60 ± 0.25 and 5.20 ± 0.20 to 5.40 ± 0.32 respectively for duck meat

sticks prepared by recipe I and those for sticks prepared from recipe II ranged from 5.40 ± 0.25 to 6.00 ± 0.20, 5.20 ± 0.20 to 5.40 ± 0.40, 5.20 ± 0.20 to 5.40 ± 0.40 and 5.20 ± 0.20 to 5.60 ± 0.25 respectively for flavour, juiciness, tenderness and overall acceptability, irrespective of duration of storage.

The present study revealed that an acceptable and nutritions duck meat product viz., duck meat stick could be prepared from deboned minced meat of desi spent ducks and stored upto 60 days at -15°C without any quality deterioration.

Baker and Darfler (1977) stated that the tenderness was not affected by storage periods. Ahmed *et al.* (1984) conducted studies on ducks and observed that tenderness scores were not influenced by the sex, and also reported that juiciness scores and flavour scores were not affected by different storage conditions. Narayanankutty and Nair (1981) reported that there was no differences in the acceptability score obtained from steaks prepared from chicken and duck meats. Narayanankutty *et al.* (1983) conducted storage studies on chicken steaks and reported that steaks prepared from deboned minced meat of spent hen were accepted. The scores for flavour, juiciness, tenderness and overall acceptability were superior. Khanna and Panda (1984) could store the duck sausage for 30 days at -10°C without adversely affecting its

organoleptic acceptability. Rejikumar *et al.* (1991) conducted studies on chicken meat balls developed using two recipes from the deboned minced broiler chicken meat and found that differences in scores for flavour, juiciness, tenderness, and overall acceptability were not found to be significant statistically between zero and any other days of storage at -15°C. Barkataki *et al.* (1994) conducted studies on quail meat patties and observed that the scores for flavour, tenderness, juiciness and overall acceptability were not found significantly different at -15°C, irrespective of days of storage. The findings of the present study are in close agreement with those reported by the above workers with regard to the acceptability and shelf-life of the product.

Cooking loss

The mean per cent cooking loss of duck meat sticks prepared as per two recipes and stored at -15°C for varying periodswas determined. The per cent cooking loss averaged 19.45 ± 0.06, 18.33 ± 0.06, 18.74 ± 0.06, 18.01 ± 0.06, 17.97 ± 0.06 and 18.02 ± 0.06 respectively for zero, 15, 30, 40, 50 and 60 days for the sticks prepared for recipe I and for the sticks prepared by recipe II the values averaged 19.91 ± 0.07, 18.51 ± 0.07, 18.82 ± 0.07, 18.63 ± 0.07, 18.07 ± 0.07 and 18.05 ± 0.07 respectively for zero, 15, 30, 40, 50 and 60 days. The statistical analysis revealed that the cooking loss was influenced by storage periods and the differences in

cooking loss between zero and any other periods of storage was statistically significant ($P<0.05$). The results of the study are in agreement with those reported by Glenn *et al.* (1960) who reported that the mean per cent cooking losses varied from 18.8 to 24.9 in chicken broilers. The per cent cooking loss of cooked duck was reported to be 18 with a range of 15 to 26 (Mountaney, 1983) and Thind *et al.* (1988) reported that the cooking loss of the patties was found to be 18.8 per cent at the end of 60 days of storage. A decrease in cooking loss per cent was observed with increase in the duration of storage for both recipes under frozen condition. Which is in close agreement with the findings of Thind *et al.* (1988) who reported that cooking loss decreased with increase in length of storage and this might be due to the progressive bindings of water by binder.

Based on the above findings, it appears that the proximate composition of ready-to-cook meat sticks prepared by using two recipes did not shown significant difference between fresh and frozen samples. The product stored at temperature -15°C for varying periods upto 60 days also showed comparable proximate composition. The ready-to-eat meaat sticks on organoleptic evaluation revealed that the flavour, juiciness, tenderness and overall acceptability of the product prepared by using two recipes did not differ statistically at various periods of storage at frozen temperature of -15°C. The study also revealed that the TBA values increased significantly by

freezing temperature -15°C in both recipes. The cooking loss was decreased significantly in the frozen product by both recipes. At the prevailing market rates sticks prepared making use of Recipe I were slightly cheaper.

Summary

SUMMARY

An experiment was designed and conducted to evaluate the feasibility of preparing a ready-to-cook poultry product namely, duck meat sticks from deboned minced meat of desi spent ducks by using two recipes to suit Indian palate and to study the nutritional characteristics, keeping quality, conditions of storage without deterioration of quality and overall acceptability of the product.

Desi spent ducks, two years old were used in the study. Data on processing yields, losses, meat to bone ratio and abdominal fat were collected from all the ducks. Deboned minced meat from these desi spent ducks was used for the preparation of the duck meat sticks. The product prepared as per the two recipes was stored under frozen (-15°C) temperature until further analysed for quality parameters or tested by a panel for organoleptic evaluation. The duck meat sticks were withdrawn from the freezer at zero, 15, 30, 40, 50 and 60 days of storage. The shelf-life of the product in terms of the quality parameters viz., proximate composition, oxidative rancidity, total bacterial count, organoleptic evaluation and cooking loss, was studied at each stage of storage period under frozen condition (-15°C). The yield of the product per kg deboned minced meat and its cost structure were also calculated.

The following observations were made in this investigation:

1. It was observed that the eviscerated, giblet and ready-to-cook yields averaged 60.87 ± 0.30, 9.44 ± 0.25 and 70.94 ± 0.40 per cent respectively. The loss due to blood, feather and inedible offal averaged 4.36 ± 0.24, 7.76 ± 0.32 and 16.94 ± 0.40 per cent respectively. The total loss averaged 29.06 ± 0.40 percentage in desi spent ducks.

2. The meat to bone ratio in desi spent ducks averaged 2.47 ± 0.02.

3. The per cent abdominal fat in desi spent ducks averaged 0.63 ± 0.02.

4. The proximate components of the product were not influenced by the two recipes under frozen storage temperature and periods employed in the study. The proximate composition remained unaltered at deep freezing temperature and periods of storage. The chemical composition of the product was found to agree with the reported values for the poultry meat and meat products.

5. At deep freezing temperature (-15°C) the TBA values increased significantly with each incremental storage period for the sticks prepared by both recipes.

6. The total bacterial count per gramme of the product decreased significantly for each period of storage under frozen condition for the sticks prepared as per recipes I and II.

7. The organoleptic evaluation of cooked duck meat sticks prepared using the two recipes and stored at deep freezing temperature for different storage periods revealed that the product prepared by both the recipes were equally good and acceptable. The organoleptic evaluation revealed that the product could be stored upto 60 days at -15°C without any loss in quality.

8. The mean per cent loss due to cooking loss decreased with increase in length of storage irrespective of recipes.

9. It was found that from each one kg deboned minced duck meat, 15.25 duck meat sticks of 100 g each could be made as per recipe I and 15.50 duck meat sticks could be made from recipe II.

10. The cost structure revealed that cost of each duck meat stick prepared as per recipes I and II was Rs.5.63 and Rs.5.73 respectively.

On the basis of the above findings it was concluded that a highly acceptable duck meat product in the form of duck meat sticks could be prepared from deboned minced spent duck meat.

The optimal condition for its long term storage was determined to be -15°C. At this temperature the duck meat sticks could be held upto two months without any qualitative changes or deterioration.

Plate 1. Ready-to-cook duck meat sticks packed in butter paper

Plate 2. **Ready-to-cook duck meat sticks**

Plate 2. **Ready-to-cook duck meat sticks**

Plate 3. Ready-to-eat duck meat sticks

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* Originals not consulted

FORMULATION AND SHELF LIFE OF DUCK MEAT STICK

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ABSTRACT OF A THESIS

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ABSTRACT

A study was conducted to examine the feasibility of formulation of duck meat sticks from deboned minced meat of desi spent ducks and to evaluate its shelf-life.

The ready-to-cook yield, total loss and meat to bone ratio averaged 70.94 ± 0.40 per cent, 29.06 ± 0.40 per cent and 2.47 ± 0.02 respectively for desi spent ducks (Two years of age) used for the study. The mean per cent abdominal fat was 0.63 ± 0.02.

The duck meat sticks prepared as per two recipes were kept under frozen (-15°C) storage upto 60 days. Representative samples were analysed qualitatively and evaluated organoleptically by a taste panel at zero, 15, 30, 40, 50 and 60 days of storage under frozen conditions. It was observed that under different days of storage the proximate components viz., moisture, protein, fat and total ash of the product remained unaltered. At -15°C the thiobarbituric acid (TBA) number increased as the storage period increased. The total bacterial count decreased significantly ($P>0.01$) at -15°C with increase in the duration of storage. The duck meat sticks prepared by both the recipes were found to be equally good and acceptable organoleptically. The mean per cent of the cooking loss decreased with increase in the length of

storage. It was observed that 15.25 and 15.50 meat sticks could be made from each 1000 g of deboned minced duck meat using recipes I and II respectively. The cost of each duck meat stick weighing 100 g was found to be Rs.5.63 and Rs.5.73 for recipes I and II respectively.

From the above findings it was concluded that a highly acceptable, nutritious, ready-to-cook duck meat product could be prepared from deboned minced spent duck meat. Under frozen (-15°C) conditions, the product could be stored upto 60 days without any quality deterioration and consumer acceptance did not vary on storage of the product.