

QUALITY OF RETORT POUCH PROCESSED TRADITIONAL CHICKEN BIRIYANI

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THESIS

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DECLARATION

I hereby declare that the thesis entitled “**Quality of retort pouch processed traditional chicken *biriyani***” is a bonafide record of research work done by me during research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or another similar title, of any other University or Society.

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LIST OF ABBREVIATIONS

% : Percentage

pH : Log hydrogen ion concentration

C : Celsius

cfu/g: Colony forming units/ gram

cm : Centimetre

µg : Microgram

g: Gram

kg: Kilogram

ml: millilitre

kcal: Kilocalories

s : Second

h : Hour

rpm : Revolution per minute

M : Molar

N : Normal

min : Minutes

1. INTRODUCTION

Traditional Indian cuisine, known for the use of a variety of spices, played an integral part of Indian history. It is widely acknowledged that the series of events that shaped Indian history began from the opening of spice trade. The foreign invasion and the colonial period that followed contributed immensely to the further development of cooking traditions. Traditional foods reveal a lot about the cultural legacy a region holds by connecting to the past. It revolves around the local raw materials and contributes considerably to the economy. According to the ingredients added, social history and geographical locations, the manner of preparation of the traditional dishes differs. Chicken *biryani* is such a dish that shows variation in the method of cooking based on geographical locality. Many relishes traditional chicken *biryani* and often choose it for grand occasions.

Traditional chicken *biryani* is a combination of rice and chicken infused with a balanced spice blend. This helps in attaining a distinct flavour and taste. There are different opinions on the evolution of *biryani* in India. A line of thought traces the lineage of the dish to Persia, from where the Mughals introduced it to India. Since Malabar served for long as an important maritime trading post, it is considered that the Arabic merchants brought in the *biryani*, thus introducing Keralites to the flavourful meal. In most of the traditional chicken *biryani* preparations of Malabar, unlike the commonly used *basmati* rice, *Kaima* or *jeerakasala* rice is used. Compared to *basmati* rice, these varieties of rice are shorter and sweet scented. The *jeerakasala* rice belongs to the category of low amylose content rice group and requires a lower cooking time. The local farmers and tribes cultivate this rice in the Thirunelli, Mananthavady and Sulthan Bathery areas of Wayanad and it is GI tagged. *Kaima* rice is also a scented rice variety of Wayanad and is preferred for preparing *payasam*, *biryani* and breakfast dishes.

Majority of Keralites are non-vegetarians. In Kerala, meals predominantly consist of rice and fish. A variety of dishes, which are combinations of both carbohydrate and protein, are found throughout Kerala. Some of these include *pidiyum kozhiyum*, *irachipathiri*, *kappa-beef*, *appam with meen molee/ meen mulakittath/ varutharacha kozhi curry*, *biryani*, *idiyappam-chicken stew etc.* Most of these dishes are influenced by Portuguese, French, Dutch and British style of cooking. The population of Kerala, which

comprises principally of Hindu, Christian and Muslim community also claims firm impact on the cuisine of Kerala. A drastic change in lifestyle and economy happened over time and along with that food habits also changed. Consumers now favours a variety of meat and among them chicken is most preferred. The frequency of meat consumption has also increased. Even then, affinity for rice-based meals has remained the same.

With increase in the earnings of people, the expenditure pattern on food items changed substantially. In the present world scenario of changing lifestyle, increased work pressure and nuclear families, the demand for ready-to-eat processed foods has increased. Convenience food consumers are mostly the urban working class with small families. A significant share of the market of convenience food industry in India constitutes of traditional food, as the families have a preference to conventional foods. The food processing industry has shown significant growth following urbanisation and outlets supplying processed foods and meat have increased in India over time. Since the refrigeration chain is difficult to maintain in Indian conditions, thermal processing and shelf stable foods are slowly gaining popularity. Thermal processing aims at eliminating pathogenic as well as spoilage microbes by subjecting the food to a specific time-temperature combination. Canning is a well-accepted thermal processing method. After the destruction of the organisms of public health importance by subjecting it to high temperature, the sealed chamber of the can acts as a sterile environment. Canned foods gained popularity following growth of cities and the changes in lifestyle of the nuclear families. Even though it costs more, the urban working class greatly appreciated the convenience and safety of such foods. Canning boasts a long history and the process has developed greatly over time. Glass containers were used during the past, which was followed by wrought iron cans and tin cans. Presently, tin-coated steel and aluminium cans are being used.

The growth in this field contributed to the development of retort pouches. These are flexible pouches made of laminates of plastics and metals. A variety of different plastics and metals may be used according to the required properties. Retort pouch processing is done to achieve long-term food preservation without refrigeration of the food. Food companies in USA in association with the US Army developed retort pouches during the 1960s. Since then great progress has happened and a variety of foods are now available in retort pouches. Now, ready-to-eat foods are available in different kinds of

pouches such as pillow type pouches, stand up pouches, pouches with zipper and pouches with spout. Consumers find it more convenient, attractive, easy to handle and appealing than conventional cans. In India also a variety of traditional vegetarian foods, curries etc. processed in retort pouches are available commercially. Attempts are being made to standardise different recipes so that more ready-to-eat traditional food products are available at the convenience of consumers.

In this background, a study was proposed to assess the quality of retort pouch processed traditional chicken *biriyani* by analysing the quality attributes on 0, 30, 60, 90 and 120 days of storage. The objectives of study were,

- 1) Optimise the retort processing traditional chicken *biriyani*
- 2) Evaluate the physico-chemical, microbiological and sensory attributes of the product
- 3) Assess the shelf-life of the retorted product.

2. REVIEW OF LITERATURE

2.1. *BIRIYANI*

Wilson (2010) stated that, *biriyani* is a spicy, flavourful recipe prepared in ghee and is very much liked in grand events.

Ahmed (2012) stated that the word *biriyani* had its origin from the word, *beriyā(n)*, which is Persian meaning ‘roasted’ or ‘fried’. He also stated that a different variety of this dish could be found in South Asia, which would be known by the place where it was prepared or by the name of the chef who contributed the recipe.

The spice rich *biriyani*, with its unmistakable flavour and aroma, is in high demand nationally and internationally (Soman *et al.*, 2020).

In a study conducted by FICCI (Federation of Indian Chambers of Commerce and Industry) in 2018, it was estimated that the organised *biriyani* sector amounted to Rs. 2500 crore worth a year and that many eminent players in this industry was planning to expand the business internationally (Alam *et al.*, 2021).

2.2 CHICKEN

Processing of chicken to a temperature above 55°C caused myoglobin denaturation, resulting in a pale, white coloured meat. But processing at even higher temperatures initiated Maillard reaction and development of flavour components (Guidi and Castigliego, 2010).

Chicken thigh and breast portions are considered as the most popular cuts. Compared to chicken thigh, breast portion is having more protein and less fat and collagen and is a healthier option for those trying to reduce weight (Jayasena *et al.*, 2013).

Traits such as tenderness and juiciness were influenced by thermal processing, which in turn affected the palatability. Thermal processing rendered meat safe to consume and imparted tenderness by disintegrating connective tissue, rather than acting on myofibrillar proteins (Pizato *et al.*, 2014).

High content of polyunsaturated fatty acid was held responsible for the rapid spoilage of chicken meat. Lipid oxidation could cause deterioration of most of the quality

specifications and could cause palpable changes in characters like texture, odour, flavour and nutritional value (Zhang *et al.*, 2016).

Chicken meat represented an easily accessible source of high grade protein and nutrients required for efficient functioning of body. It was less pricey, favoured by health conscious consumers and was not bound by religious or cultural regulations and hence universally popular (Kralik *et al.*, 2018).

2.3 NON-MEAT INGREDIENTS

Aruna and Baskaran (2010) stated that bioactive agents of spices were in use for long in the traditional Indian medicine systems. The active compounds possessed anti-inflammatory, anti-oxidant and anti-viral properties and motivated detoxification of enzymes.

Fife (2013) observed that medium chain fatty acids were the predominant group of fat molecules present in coconut oil and fat accumulation in the arteries and their resultant hardening was not caused due to these molecules, which were absorbed very quickly from the blood stream compared to other fat sources. He also stated that high density lipoprotein, which was beneficial for health was contributed by the consumption of coconut oil.

Studies revealed that onion and garlic were having many beneficial properties such as anti-fungal, anti-microbial, hepatoprotective and anti-oxidant actions. These properties were attributed to the presence of sulphur containing compounds like S-allyl-l-cysteine, diallyl trisulfide, diallyl disulphide, ajoene, and allicin (Bisen and Emerald, 2016).

Ghee, owing to its negligible moisture content and inherent anti-oxidant properties, is a highly shelf stable fat manufactured from milk based on different processing techniques. Ghee is also thought to be healthier and tastier due to the presence of short chain fatty acids and essential fatty acids (Kumar *et al.*, 2018).

Rice is a good source of complex carbohydrates, amino acids such as lysine, B-complex vitamins and almost deficient in fat, salt and cholesterol. Recent studies revealed that traditionally cultivated rice, which was usually maintained and preserved by the rural tribal people, had rich content of essential fatty acids, amino acids with high biological

value and minerals such as selenium. Traditional rice varieties of Kerala had inherent properties like resistance to flood, draught, salinity, pests and alkalinity (Chaudhari *et al.*, 2018).

2.4. PRINCIPLES OF RETORT PROCESSING

Durance (1997) stated that decimal reduction time, D, was involved in the kinetics of a thermal treatment. It is the heating time in minutes, that was supposed to inactivate at least 90% of the organisms present. He also mentioned that z value was the temperature change required for a 10-fold change in D, and was termed as decimal reduction temperature. The lethality (Fo), also known as cold-spot lethality, was the heating time in minutes at 121.1°C, that is required to reduce the concentration of a heat labile constituent by tenfold.

Thermal processing caused protein denaturation, thus solubilising protein and deactivation of enzymes. The reddish colour of meat changed to brown due to the commencement of Maillard reaction, juiciness developed and better flavour could be perceived due to the release of fats. A large amount of water was lost at a processing temperature of 50 to 60 °C. The water loss reached 80-100% when the temperature attained 80 °C (Kelly *et al.*, 2005).

Awuah *et al.* (2007) stated that in container sterilisation of foodstuff was the basic concept behind thermal processing. This primarily involved the destruction of the organisms of public health importance by subjecting it to high temperature for a sufficiently long time. The seal prevented the growth of microbes and maintained the environment inside the container by preventing recontamination.

Holdsworth and Simpson (2007) stated that the heat applied during thermal processing caused the inactivation of micro-organisms and the proper cooking of the food product, which provided an acceptable texture and destroyed active enzymes. Since it had a negative effect on the colour, nutrients and other quality attributes, equilibrium had to be achieved between excessive heating and under processing, and this process was known as optimization.

Bacillus and Clostridium are the two most important genres of microbes that are of concern in thermal processing. They produce heat resistant endospores and endospores

of *Clostridium botulinum* can generate fatal toxins. Since it is impossible to set a time-temperature combination that will kill each of the spore present, to prevent a public health hazard, it is essential to create a very low probability of spore survival. In case of low acid foods, it is aimed to achieve a chance of spore survival of one in 10^{12} or better. This is considered as the 12D process. Though this process does not destroy all of the heat resistant thermophiles, it can deal with the pathogenic organisms in a commercial process. So, this system is known as commercial sterilisation (Holdsworth and Simpson, 2007).

Nicolas Appert in 1810 introduced the idea of canning and it aimed at eliminating spoilage causing pathogens to extend shelf life by applying heat energy (Mandal, 2011).

In thermal processing, more than absolute sterility, commercial sterility was given significance and it meant that a very small chance would be there for a microorganism to survive the processing. In canning, *Clostridium botulinum* was the organism that might cause a hazard and in addition, for achieving commercial sterility, spores of *Bacillus* were to be controlled (Membré and Van Zuijlen, 2011).

Le Bourvellec *et al.* (2018) stated that severe application of heat processing and prolonged storage would facilitate chemical reactions influencing the food grade, resulting in the reduction of the quality of vitamins, polyphenols and carotenoids.

Maldonado-Pereira *et al.* (2018) observed that changes caused by chemical reactions would lead to change in the composition of fatty acids, lipid oxidation and development of cholesterol oxidation products.

Bhat *et al.* (2021) observed that thermal processing was an important step in establishing food safety and public health and involved processing the product to a particular core temperature. The time-temperature combination applied to render meat free from spoilage causing pathogens varied depending on the type of meat being cooked, cooking procedure used and legislation of the country. The temperature attained and the rate of heating influenced protein denaturation.

2.5. RETORTING

The flexible retort pouches were developed in USA by a consortium of companies in food industry and the US Army Natick Laboratories in 1960s (Herbert and Bettison, 1987).

Retort processing systems could be broadly divided into continuous retorting system, which is more efficient and economical with high production rate and batch retorting system, which offers the advantage of being able to process different sizes and types of retortable containers. Both of these systems are further subdivided into static or still retorts, where there is no movement of containers during processing and rotary retorts, where there is agitating movement of the containers (Jean and Bruce, 1997).

The high cost and the inconvenience of handling canned goods led to a decline in its consumption and gave way to the emergence of retort pouch processing as a suitable substitute for canning process. It had many advantages over conventional canning method, which made them a popular choice (Rajkumar *et al.*, 2010).

Byun *et al.* (2010) thermally processed salmon in various kinds of retort pouches and compared the quality and shelf stability. Processing was done for 23 min at 121 °C and 206.84 kPa so that F_0 values of 6 was achieved and pouches were stored at 37.7 °C and a relative humidity (RH) of 90%.

Retort pouch processing of shrimp in curry medium was done at F_0 5, 7 and 9. The respective total process times were found to be 20.09, 24.31 and 28.69 min, respectively (Mallick *et al.*, 2010).

Bindu *et al.* (2010) observed that retort processing had many advantages over conventional canning: for example, the pouches required reduced storage space, had ease of handling and opening, required less cost of production and had improved heat penetration qualities, which allowed reduction in processing time and cooking time.

Noh *et al.* (2011) conducted a study to investigate retort processing of seasoned sea mussels at F_0 ranging from 7-13. Chemical composition as well as microbiological quality were analysed during the study and the data showed best results, both economically and in terms of shelf stability at F_0 7.

Catauro and Perchonok (2012) experimented on a variety of dishes, including meat, vegetables, fruits, dairy products and dessert products, for obtaining data to find out the suitability and convenience of retort processed foods in pouches for use in spaceflights. The methodology employed in assessing the shelf-life endpoints were sensory evaluations, nutritional analysis and physical property assessments. The results were

either observed on analysis or projected mathematically. It was concluded that among the different foods, meat maintained its quality the longest, for a time period of 2 to 8 years in pouches. The significant loss of vitamin B and C over time was compensated by the safety, increased acceptability, reduced amount of nutrient lost compared to that of canning and the convenience it offered.

Muhlisin *et al.* (2013) aimed at optimising the processing conditions of shelf-stable retort pouched *Chuncheon Dakgalbi*, a chicken dish from Korea. The product was subjected to varied cooking times such as 10, 20 and 30 minutes at 110 °C and it was noted that autoclaving for 30 minutes provided the most shelf-stable product with preferable characters.

Majumdar *et al.* (2017) optimised the retort processing of boneless fish ball from *Rohu* fish in gravy at an F_0 value of 7 minutes and a total process time of 42.21 minutes at 121.1°C.

Shah *et al.* (2017) conducted storage study on retort pouch processed *Rogan josh*, a meat dish of Kashmir origin. The curry was processed at 121 °C at F_0 varying from 7 to 11 and it was observed that the curry processed at F_0 value of 9 gave the best desirable characters. Upon sensory and microbiological analyses, it was found that a storage stability of 12 months could be achieved.

Girish *et al.* (2018) found that an F_0 of 11.81 was required for retort processed ready-to-eat pork curry. The processing time in total was 48 minutes and under ambient temperature, the product was shelf-stable until 6 months.

2.6. PACKAGING MATERIALS FOR RETORT PROCESSING

Packaging materials of thermally processed food requires certain properties such as the ability to withstand high temperature and pressure, oxygen and water barrier properties as well as mechanical properties like tensile strength and elongation at break (Bull *et al.*, 2010).

Kim *et al.* (2014) stated that the properties of the food being packaged, food processing method, cost, market image and environmental factors determined the choice of packaging materials. He also stated that glass jars were used by Nicolas Appert in the

development of canning. Later, in 1810, Peter Durland started using tin plated metal containers for canned liquid food.

The bonding of two or more substrates by heating or adhesives produced laminated films. When aluminium foil was laminated, a variety of papers and plastics were used as substrates, with water or solvent based adhesives as well as waxes so that an improved functionality in terms of barrier properties was achieved (Bayus *et al.*, 2016).

Chonhenchob *et al.* (2017) stated that the newer developments in retort pouches included, transparent retort pouches, made by replacing central aluminium layer with oriented polyamide, EVOH or PVDC and resealable pouches that were provided with zippers.

Shah *et al.* (2017) retort processed *Rogan Josh*, a traditional meat dish of Kashmir, using multilayer laminated retortable pouches made of polyester, aluminium foil and cast polypropylene/biaxially oriented nylon.

Ready-to-eat cassava was retort processed by Dinakaran and Panda (2017) in see through pouches composed of polyester coated with silicon dioxide, nylon and cast polypropylene.

Kim *et al.* (2018) found that poly trimethylene terephthalate showed good results in replacing polyethylene terephthalate (PET) and nylon in retort pouches, which made them more eco-friendly due to the biodegradable nature of the material.

Tinplate, tin-free steel (TFS), aluminum, and stainless steel (SS) are the commonly used metal packaging materials, of which aluminium is most popular. The metal packaging forms are of many different types and three piece cans are made of two end lids and a body, while two piece cans consist of one end (lid) with a seamless body (Deshwal and Panjagari, 2020).

Deshwal and Panjagari (2020) stated that, retort pouches were being recognised as a better alternative to metal cans economically and in terms of convenience. Typically, pouches produced were made of three or four layer of films; an outer layer of polyester, a core made of aluminium which provided necessary odour, water and gas barrier properties to the laminate, a central layer of nylon for abrasion resistance and an inner polypropylene layer which provided good heat seal and overall strength.

2.7. PHYSICO- CHEMICAL CHARACTERISTICS

2.7.1. pH

Jang and Lee (2012) concluded that the decreasing pH value in ready-to-eat ginseng chicken porridge was due to the process of oxidation of the lipids and the presence of by-products of Maillard reaction.

Devadason *et al.* (2014) evaluated the pH of the buffalo meat blocks processed in retort pouches, at 15 days' interval and observed a gradual decline during storage of three months.

Peñaflor *et al.* (2017) stated that vibration of molecules accelerated upon heating such as during retort processing caused obstruction to the formations of hydrogen bonds, and thus produced more free hydrogen ions, resulting in a reduction of pH.

Shah *et al.* (2017) reported that pH values of meat chunks in retort pouch packaged *Rogan josh*, a traditional meat curry from Kashmir, decreased with increase in F_0 value due to protein liberation and degradation of free amino acids.

Shange *et al.* (2018) observed that vacuum packaged black wildebeest meat under chiller storage showed faster growth rates of lactic acid bacteria and had higher total viable count when pH was ≥ 6.0 when compared to meat with pH < 6.0 .

Praharasti *et al.* (2019) analysed physicochemical properties of beef rendang in retort pouch packaging in various temperature storage conditions and observed that at higher temperature storage, pH value of the meat tended to decrease.

According to Katiyo *et al.* (2020) increase in pH of chicken meat due to spoilage showed darkening of the meat because of increase in alkaline nitrogenous compounds like ammonia and amines.

Zarim *et al.* (2021) while studying shelf life stability and quality of texture modified chicken rendang observed that pH significantly reduced throughout the duration of storage, and this reduction was attributed to the changes that occurred in the myofibrillar protein through which hydrogen bonds were split and positive hydrogen ions were released.

2.7.2. Thiobarbituric Acid Reactive Substances (TBARS) Number

TBARS values were noticed to be low in retort pouch processed *Chettinad* style goat meat curry during storage (Rajkumar *et al.*, 2010).

It had been reported by Lavanya *et al.* (2016) that the free fatty acids increased with increasing rancidity and storage time in mutton *kheema biriyani*. As such, the TBARS value increased when storage time increased.

Bubelová *et al.* (2017) when analysing long life foods such as pork pate, canned chicken meat, and canned tuna fish, found that there was an increase in TBARS, caused by both higher storage temperature and storage length. In a three month study, they detected highest TBARS levels in all products, which were stored for three months at 40 °C when compared to products stored at -18 °C, 5 °C and 23 °C.

Shah *et al.* (2017) stated that a major cause of chemical spoilage in meat and meat products was lipid oxidation. Free radicals produced as a result of lipid oxidation might lead to the oxidation of meat pigments and cause rancid flavours and odour with production of potentially toxic chemical substances. They observed that the TBARS values in meat increased with increase in processing time for retort packaging.

Girish *et al.* (2018) noticed that the TBARS number in shelf stable ready-to-eat pork curry increased significantly during storage. They came to the conclusion that the increase in TBARS number might be because the pouches were not vacuum sealed and the residual oxygen in the pouch caused lipid oxidation.

A significant increase in TBARS number was reported by Thakur and Rai (2018) in ready-to-eat retort processed rice pulav, during the storage period of 180 days.

2.7.3. Tyrosine Value

Rajkumar *et al.* (2010) observed that in retort pouch processed *Chettinad* style goat meat curry stored at ambient temperature, tyrosine value increased significantly after processing when compared to the value before processing.

Devadason *et al.* (2014) while assessing the shelf life of retort pouch processed buffalo meat blocks observed that there was significant linear increase of tyrosine value from 0.35 to 0.74 mg/100 g with increase of storage time. They concluded that tyrosine

value was an indicator of proteolysis because it measured tyrosine and tryptophan from the meat extract.

Rajan *et al.* (2014) found that the tyrosine values increased significantly during the storage period of 180 days in retort processed *Chettinad* chicken curry. They noted that when spent hen meat was used in the curry, the tyrosine values increased from 83.0 to 99.3 mg/100 g and while using broiler meat the value increased from 79.4 to 103.7 mg/100 g.

Nalini *et al.* (2018) found that the tyrosine value increased significantly from 6.04 ± 0.03 to 6.93 ± 0.05 in 90 days of storage of pepper chicken processed in retort pouches.

2.7.4. L* a* b* Colour Values

Bindu *et al.* (2010) reported that in retort processed ready-to-eat fish *peera*, there was an increase in a* (red-green scale) values as storage time increased. They also noted that there was no significant variation in the b* (yellow-blue scale) values of both fish chunks and gravy during the entire storage period of 12 months.

Rajkumar *et al.* (2010) observed reduced L* (perceptual lightness), a*, b* and chroma values in *Chettinad* style goat meat curry processed by retorting in pouches when compared to freshly prepared curry. According to them maillard reaction between sugar and amino acid during retorting might have lowered the colour scores of the product.

Jang and Lee (2012) evaluated ready- to- eat ginseng chicken porridge and recorded that Hunter L* and b* values increased significantly during storage, whereas the Hunter a* values decreased. Their hypothesis was that the changes in colour during storage of porridge might be due to the different physico-chemical reactions such as Maillard reaction, disintegration of structure in the porridge and broth phase of the dissolved components of rice porridge.

Muhlisin *et al.* (2013) analysed retort pouch packed *Chuncheon Dakgalbi*, a Korean dish prepared with chicken and found out that the lightness values (L*) when stored at room temperature increased during the first two weeks of storage and then reduced on the third week of storage. With increase in storage time the redness value, a* increased for meat chunks, whereas for gravy it decreased.

During the colourimetric evaluation of mutton *kheema biryani*, Lavanya *et al.* (2016) found that there was no noticeable increase in the L* and b* value. However, a decrease in a* value was observed during the storage period of sixty days and they mentioned that colour of cooked meat products could be influenced by fat present.

Majumdar *et al.* (2017) analysed the changes in the colour parameters in prawn curry during the thermal processing at different F₀ values. The L* value (lightness) and b* value (blue to yellow) decreased with increase in F₀ values. It was noted that a* value (green to red) increased when F₀ values increased. They suggested that the change in colour might be due to increase in heat treatment time and the increase in a* value in the product might be due to the release of astaxanthin pigment by prolonged heat treatment.

Changes in the colour (L*, a*, b*) values of retorted *Rogan josh* were observed by Shah *et al.* (2017) and it was recorded that L* (lightness) value increased with increase in storage time in both gravy and meat chunks.

Significant decrease in L, a* and b* values of retort processed pepper chicken was reported by Nalini *et al.* (2018) during a storage study of ninety days.

2.8. PROXIMATE PRINCIPLES

Byun *et al.* (2010) while studying the shelf life of ready-to-eat rice products after retort processing found that during the 12-week storage time the moisture content of both plain and the chicken flavoured rice decreased slightly.

The proximate composition of retorted ginseng chicken porridge was evaluated by Jang and Lee (2012) and they found the values for crude protein, crude fat, crude ash and carbohydrate contents as 6.6, 1.6, 0.5 and 7.0%, respectively.

Kumar *et al.* (2013) analysed ready to eat retort packed chicken *pulav* and observed that the values (%) of fat, protein, ash and carbohydrate were 8.15 ± 0.1 , 7.4 ± 0.05 , 1.65 ± 0.01 and 18.2 ± 0.25 , respectively.

Lakshmana *et al.* (2013), while studying the nutritional qualities of retort pouch processed tender jackfruit curry found a decrease in fat content and non-significant changes in carbohydrate and moisture content.

The moisture content decreased considerably in the retort processed *Chettinad* chicken curry produced using spent chicken meat and broiler meat during the storage period of 180 days (Rajan *et al.*, 2014). They observed that the curry with spent hen meat and broiler meat had crude protein contents (%) of 19.9 ± 0.08 , 25.5 ± 0.17 , fat contents (%) of 36.6 ± 0.25 , 33.1 ± 0.32 and ash contents (%) of 3.4 ± 0.09 , 3.4 ± 0.11 .

Lavanya *et al.* (2016) processed mutton *kheema biryani* in retort pouches and stored at ambient temperature for 60 days and found that proximate composition varied during storage. Protein (%), fat (%) and carbohydrate (%) reduced from 7.912 ± 0.085 to 7.789 ± 0.156 , 4.426 ± 0.084 to 3.947 ± 0.287 and 14.142 ± 0.400 to 12.376 ± 0.023 , respectively. However, ash (%) increased from 4.606 ± 0.273 to 4.829 ± 0.063 . Even though moisture showed a slight increase, the change was not significant.

Chandirasekaran and Rajan (2016) found that the moisture content decreased significantly in retort processed *Chettinad* chicken produced using spent chicken and broiler chicken meat.

When Gobikrishnan *et al.* (2019) estimated total carbohydrate, protein and fat of the retort processed traditional rice dumpling, a degradation in their amount was noticed during a storage period of four weeks.

2.9. MICROBIOLOGICAL PARAMETERS

2.9.1. Aerobic Plate Count

Rajkumar *et al.* (2010) reported the absence of coliforms, yeast and mould and *Staphylococcus* in retort packaged *Chettinad* goat meat up to 10 months of storage.

After 28 weeks of storage and analysis of ready-to-eat ginseng chicken porridge, which was processed with F0 4 min, Jang and Lee (2012), found that there was no microbial growth over the detection level ($< 1.0 \log \text{cfu/cm}^2$).

Rajan *et al.* (2014) was not able to detect any *E. coli*, *Salmonella spp.*, *Staphylococci spp.*, as well as yeast and mould in the *Chettinad* chicken samples prepared using retort processing during the entire storage period.

Shah *et al.* (2017) analysed samples of *Rogan josh* in retort pouches for total plate count and found no microbial growth during the entire storage period. They concluded

that the microorganisms must have been destroyed by the temperature applied while retort processing and the packed products were kept sterile due to the integrity and high barrier properties of retort pouch materials used.

2.9.2. Anaerobic Plate Count

Rajkumar *et al.* (2010) observed that *Clostridium botulinum* was absent in retort packaged *Chettinad* goat meat during 10 months of storage.

Anaerobes were totally absent in buffalo meat blocks processed in retort pouches during the storage period (Devadason *et al.*, 2014).

Chettinad chicken processed in retort pouch was free of anaerobe colonies (Rajan *et al.*, 2014).

While studying the shelf life of retort packaged texture-modified chicken rendang using xanthan gum, Zarim *et al.* (2021) observed that there was no presence of anaerobic bacteria during 6 months of storage. They concluded that the retort packaging might have inactivated the microorganisms.

2.10. SENSORY ANALYSIS

Rajkumar *et al.* (2010) reported that during sensory evaluation the texture scores for the *Chettinad* style goat meat prepared in retort packaging reduced from 8.20 to 7.07 during its 10 months of storage. They concluded that even though the texture score declined the product was highly acceptable by the panellist.

Sensory analysis of retort packaged chicken *pulav* on a 9-point hedonic scale by Kumar *et al.* (2013) showed an initial score of 8.6 for colour, 8.6 for taste, 8.5 for flavour and 8.5 for the overall acceptability. After 4 months of storage the sensory scores of chicken *pulav* reduced both under ambient and at 45°C temperature storage. Under ambient temperature, the scores dropped to 7.2 (16.27%) for colour, 7.6 (11.62%) for taste, 7.2 (15.29%) for flavour and 7.3 (14.11%) for the overall acceptance. At 45°C, the score dropped to 7.0 (18.60%) for colour, 7.3 (15.11%) for taste, 6.9 (18.82%) for flavour and 7.1 (16.47%) for overall acceptability.

Devadason *et al.* (2014) reported that there was a significant reduction in the intensities of sensory characteristics of buffalo meat blocks in retort pouches as storage

time increased. After 90 days of storage, sensory scores for appearance had decreased from 7.6 to 6.2 when using 8-point hedonic scale.

Rajan *et al.* (2014) recorded the sensory scores for retort packed *Chettinad* chicken using both broilers and spent hen and observed that the texture scores in spent hen meat and overall acceptability scores in both cases reduced significantly, although no other sensory parameters changed significantly due to storage time.

There was a significant decrease in all of the sensory attributes of retort processed *Rogan josh*, a traditional meat product of Kashmir, stored for a year; however, the sensory scores were acceptable (Shah *et al.*, 2017).

2.11. STERILITY TESTING

Lakshmana *et al.* (2013) stated that retort pouch processed tender jackfruit curry was commercially sterile on sterility testing.

Bindu *et al.* (2010) analysed the commercial sterility of ready-to-eat fish *peera* in retort pouches and found an absence of turbidity in the test tubes, indicating sterility of samples.

3. MATERIALS AND METHODS

The study was carried out at Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode and Fish Processing Division, ICAR- Central Institute of Fisheries Technology, Kochi. Boneless breast meat of broiler chicken was procured from the local markets in Kochi, Ernakulam district and was brought to the Fish Processing Division of ICAR- CIFT, Kochi. Rice, spices and condiments were also obtained from local markets and retort pouch processing of traditional chicken *biriyani* was done using a steam-air retort. The product was subjected to physico-chemical, microbiological and sensory analyses on the day of preparation (day 0), 30th, 60th, 90th and 120th day at Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode.

3.1. STANDARDISATION AND PREPARATION OF CHICKEN *BIRIYANI*

The recipe and method of preparation of traditional chicken *biriyani* was collected from home-makers, cooks and from preliminary trials conducted in the department. The ingredients in the preparation of chicken *biriyani* are given in Table 1 and the flowchart for preparation of *biriyani* is shown in Fig.1. Preliminary trials were conducted to obtain the optimum rice: water combination. This included 1:0.8, 1:0.9, 1:0.95, 1:1, 1:1.5, 1:1.6, 1:1.7, 1:1.75, 1:1.8 and 1:2 combinations. The best rice:water combination was selected based on sensory evaluation. In addition, trials were conducted to find the optimum time required for soaking rice. Rice was soaked for 5, 10 and 15 minutes and after retort processing, based on sensory analysis and texture profile analysis, ideal soaking time was arrived at.

The boneless breast meat of broiler chicken was blanched in 6% saline solution for four minutes. The spice mix used in the *biriyani* was made by dry roasting and grinding cinnamon, clove, cardamom, pepper, fennel seeds and cumin seeds. The quantity of the ingredients is listed in Table 2. After sautéing cinnamon, cardamom and cloves in ghee in a pan, the soaked and drained rice, was added and sautéed for 2 minutes. The chicken *masala* was prepared by cooking chicken with onion, ginger-garlic paste, green chilli, mint leaves, coriander leaves, prepared *biriyani* spice mix and tomato in oil.

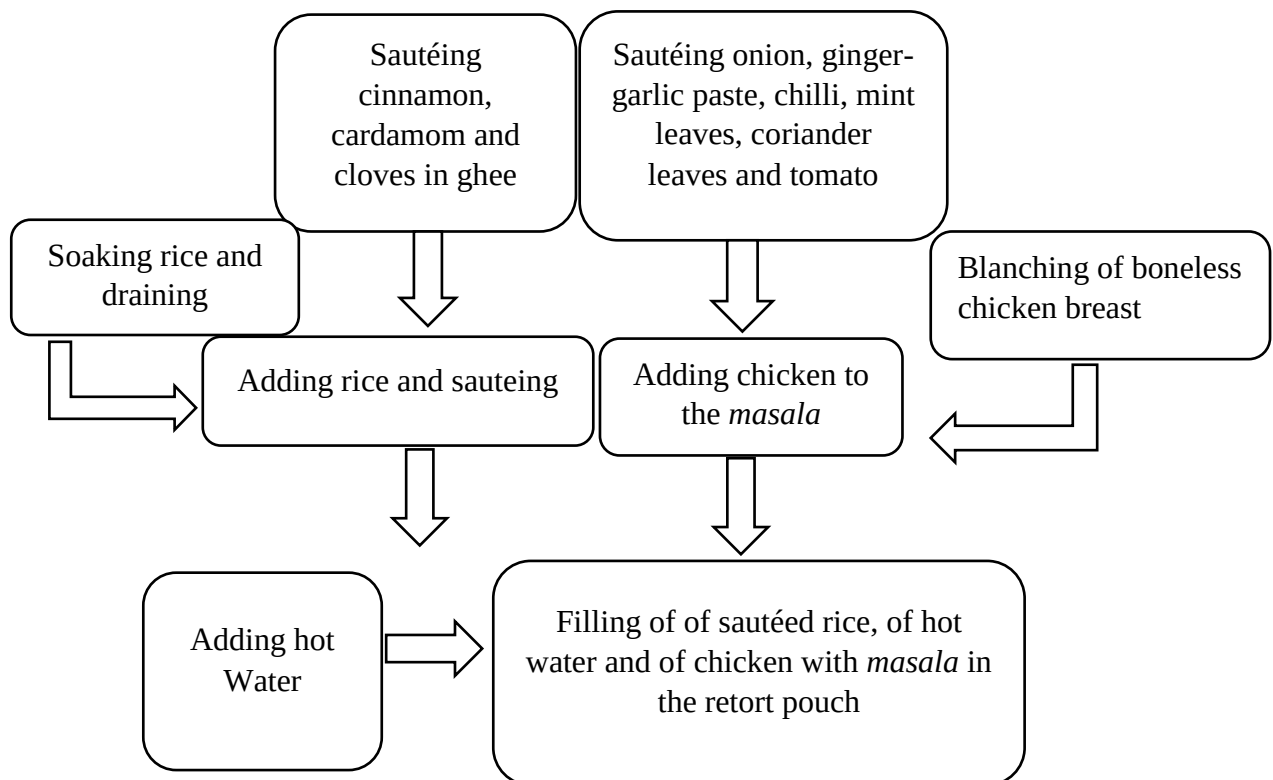
A retortable flexible pouch of 3-layer configuration, consisting of outer (12 μ) PET ALO_x, middle layer made of nylon with thickness 15 μ and inner cast polypropylene of 70 μ thickness (M/s Floeter India Retort Pouches (P) Ltd., Manesar, Haryana, India) was used for the study. The pouch had a capacity of 200 g and a size of 16 x 18 cm. Various mechanical parameters were analysed to determine the suitability of these pouches for thermal processing. The tests carried out included thickness, tensile strength and elongation at break (IS 2508, 1984) and heat seal strength (ASTM, 1973) using Universal Testing Machine (Lloyd instruments LRX plus, Hampshire, UK).

Table1. Formulation of chicken *biryani*

Ingredients	Quantity
Rice	1.5 kg
Chicken	2 kg
Onion	1.5 kg
Tomato	0.37 kg
Ginger	105 g
Garlic	88 g
Mint	60 g
Coriander	160 g
Chilly	100 g
Spice mix prepared	6 g
Ghee	50 g
Oil	150 g
Water	1.5 kg
Salt	80 g

Table2. Formulation of spice mix for the chicken *biriyani*

Ingredient	Quantity
Cinnamon	16 g
Cardamom	19 g
Clove	6.4 g
Pepper	56 g
Cumin Seeds	5.6 g
Fennel Seeds	100 g

**Fig. 1. Flow chart for the preparation of traditional chicken *biriyani* for retort processing**

3.2. RETORT PROCESSING OF CHICKEN *BIRIYANI*

Eighty grams of the prepared chicken *masala*, 50 grams of rice and 50 grams of hot water were filled in each of the retort pouch manually. Exhausting and sealing of the pouches were done immediately after filling of the pouches. The pouches were processed in a steam-air retort (John Fraser and Sons Ltd., New castle upon Tyne, UK) at 121.1°C with an Fo value of 3.5. After processing, the pouches were cooled rapidly by pumping and recirculating water into the retort. The retort temperature (RT) was maintained at 121.1°C and air pressure was maintained at 28 psi throughout the heating and cooling period. The heat penetration characteristics were evaluated by fixing the pouches with thermocouple glands (type GEM-K distance piece GEM-26008-K030, Ellab A/S, Roedovre, Denmark) through which thermocouples (type SSA 12080—G700-TS, Ellab Co. Denmark) were inserted. The tips of the thermocouples were inserted into the chicken pieces and rice for recording the core temperature during heat processing. Temperatures were then monitored using a data recorder (Ellab E val flex 9016; Ellab A/S, Rodovre, Denmark). The lag factor for heating (J_h), the slope of the heating curve (f_h), the time in minutes for sterilisation (U) and the lag factor for cooling (J_c) were calculated by plotting the temperature deficit ($RT - T_c$) on semi-log paper. The process time (B) was calculated by mathematical method (Stumbo, 1973). Total process time (TB) was determined by adding process time (B) to the effectiveness of the come-up time which has been accepted to be 58% of the come up time and the calculation is given below.

- $B = f_h [\log (J_h \times I - \log g)]$

where B=process time

I= initial deficit value

$$g = f_h / U$$

$$U = F_o \times 10^{(121.1 - RT)/Z}$$

Z= z-value

RT= retort temperature.

$J_h = \underline{\text{Pseudo initial deficit of heating}}$

Initial deficit of heating

$J_C = \frac{\text{Pseudo initial deficit of cooling}}{\text{Initial deficit of cooling}}$

Initial deficit of cooling

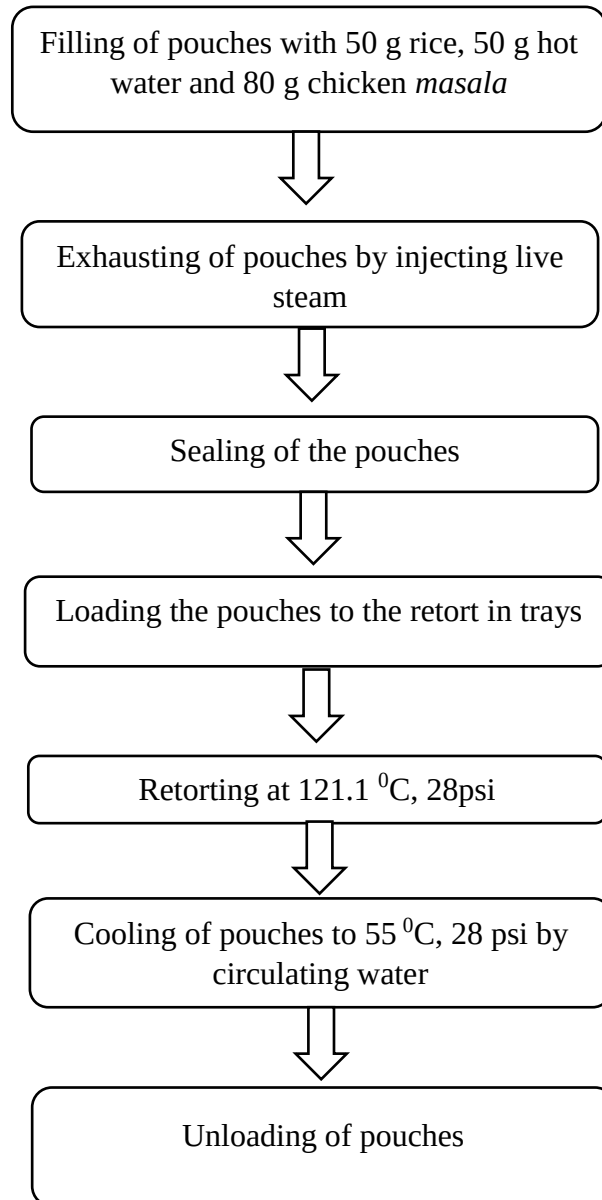


Fig. 2. Flow chart for retort processing of traditional chicken *biriyani*

3.3. PHYSICO-CHEMICAL CHARACTERISTICS

3.3.1. pH

pH of the samples was measured by using a digital pH meter as per the method described by AOAC (2016). Ten grams of sample was blended with 50 ml distilled water for one minute using a tissue homogenizer (Kinematica, Switzerland) at the speed of 4000 rpm. The pH of the homogenate was recorded by immersing the combined glass electrode of a digital pH meter (EUTECH instruments pH 510, Singapore).

3.3.2. Thiobarbituric Acid Reactive Substances (TBARS) Number

Thiobarbituric acid reactive substances (TBARS) directly indicate presence of lipid oxidation in meat and meat products. Estimation of TBARS is done by measuring the concentration of secondary lipid oxidised products like malondialdehyde.

TBARS number of the samples was determined as per Witte *et al.* (1970) with modifications. 20 g sample was blended with 50 ml chilled extracting solution containing 20 per cent trichloroacetic acid in 2 M orthophosphoric acid for two minute. The resultant slurry was transferred to a 100 ml volumetric flask and made upto 100 ml with deionised distilled water. This solution was filtered through Whatman No.1 filter paper. From the filtrate, 5 ml was transferred to a screw capped vial followed by addition of 5 ml of 2-thiobarbituric acid solution (0.005M in distilled water). The solution was mixed by inverting the vial and kept for 15 h in darkness at room temperature. The absorbance was determined at wavelength of 530 nm against blank containing 5 ml of distilled water and 5 ml of 2-thiobarbituric acid solution in a spectrophotometer (UV/VIS Biomate 3S, Thermo fisher scientific, Bangalore). The absorbance was expressed as TBARS number of sample.

3.3.3. Tyrosine Value

Tyrosine value indicates the proteolysis in meat and meat products as tyrosine is the first formed amino acid during proteolysis.

Tyrosine value of the samples was estimated as per the method described by Pearson (1968). To accurately weighed 2 g of sample, 40 ml of 5 per cent trichloroacetic acid solution (TCA) was added. After homogenisation for two minutes in a tissue

homogeniser (Kinematica, Switzerland) at the speed of 4000 rpm, the sample was filtered. The filtrates were used in the estimation of tyrosine value. To 2.5 ml of TCA extract in a test tube, equal quantity of distilled water and 10 ml of 0.5 N sodium hydroxide were added and shaken. Three millilitres of diluted Folin-Ciocalteu's phenol (FC) reagent (1 ml of concentrated FC reagent and 2 ml of distilled water), were added, mixed and the contents were allowed to stand for 5 minutes at room temperature. The absorbances were measured at a wavelength of 660 nm in a spectrophotometer (UV/VIS Biomate 3S, Thermo fisher scientific, Bangalore) using a blank containing 2.5 ml of 5 per cent TCA, equal quantity of distilled water, 10 ml of 0.5 N sodium hydroxide and 3 ml of diluted F-C reagent for comparison. By referring to the standard graph of tyrosine, tyrosine values of samples were calculated and expressed as mg of tyrosine/100 g of sample.

3.3.3.1. Standard Graph for Tyrosine

Accurately weighed 0.10 g of tyrosine was dissolved in 5 per cent TCA in a 500 ml volumetric flask and made up to the mark with double distilled water. The following volumes of tyrosine solution were added to a series of 100 ml volumetric flask: 0, 1, 3, 5, 7, 10, 12, 15, 20 ml. Each was made upto the mark with double distilled water and mixed thoroughly. Five millilitres of each solution was mixed thoroughly with 10 ml of 0.5 N sodium hydroxide solution and 3 ml of diluted Folin-Ciocalteu's (F-C) reagent and then treated as described above. The standard graph (Fig. 3) was prepared by plotting optical density against mg of tyrosine dissolved in trichloroacetic acid solution.

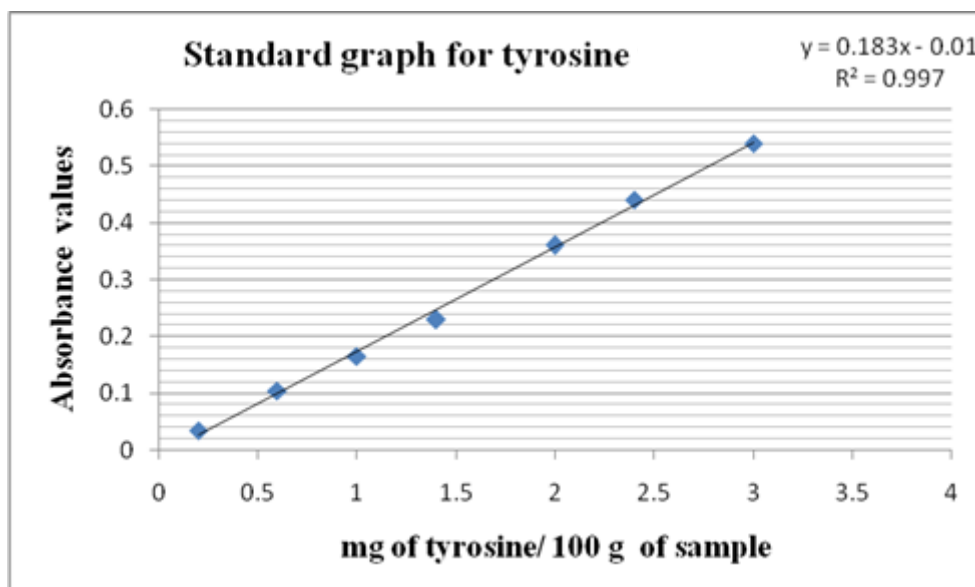


Fig. 3. Standard graph for tyrosine

3.3.4. L* a* b* Colour Values

Colour values of samples were determined as per Page *et al.* (2001) using Hunter Lab Mini Scan XE Plus Spectrophotometer (Hunter Lab, Virginia, USA) with diffuse illumination. The instrument was set to measure L* a* and b* using illuminant 45/0 and 10° standard observer with an aperture size of 2.54 cm. It was calibrated using black and white calibration tiles before starting of the measurement and colorimeter score recorded with 'L*' of black equals zero and 'L*' of white equals 100, 'a*' of lower numbers equals more green (less red), higher numbers equals more red (less green) and 'b*' of lower numbers equals more blue (less yellow), higher numbers equals yellow (less blue). The colour coordinates L* (lightness), a* (redness) and b* (yellowness) of the samples were measured thrice and mean values were taken.

3.4. PROXIMATE PRINCIPLES

The samples were analysed for proximate principles like moisture, fat, protein and ash on days 0, 30, 60, 90 and 120. The proximate principles were expressed as percentages of samples on wet matter basis.

3.4.1. Moisture

Moisture content was estimated as per AOAC (2016). About 20 g of accurately weighed and finely chopped sample in an evaporating dish was kept in a hot air oven (Rotek, Mumbai) set at $100 \pm 2^{\circ}\text{C}$ for 18 h. The weight of the dried sample was taken after cooling in a desiccator. The difference in the weight was the moisture content of the sample and it was expressed as percentage weight of the sample.

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

W1= Weight of empty dish

W2= Weight of dish + sample

W3= Weight of dish + dried sample

3.4.2. Fat

Fat content of samples was estimated as per AOAC (2016). Fat content of about three grams of accurately weighed moisture free sample was extracted with petroleum ether (Boiling range $60 - 80^{\circ}\text{C}$) using Soxhlet solvent extraction system (SocsPlusSCS 06E, Pelican Equipment, Chennai) for a period of 2.5 h. Ether extract obtained was dried to a constant weight at 100°C , cooled and weighed. Fat content on dry matter basis was converted to wet matter basis and expressed as percentage weight of the sample.

$$\text{Fat (\%)} = \frac{W_2 - W_1}{W_3} \times 100$$

W1= Weight of empty oil flask

W2= Weight of oil flask + fat

W3= Weight of sample taken

3.4.3. Protein

Protein content was estimated as per AOAC (2016). Accurately weighed sample (approximately 2 g) was digested using Micro-Kjeldhal digester (KelplusKES06LE, Pelican Equipment, Chennai) in the presence of catalyst (90 parts sodium sulphate + 10 parts copper sulphate) and 25 ml concentrated (36 N) sulphuric acid. Tubes were heated gently until frothing ceased, then boiled rapidly until solution became clear. The samples were cooled and transferred to 250 ml volumetric flask and made up the volume using distilled water. Ten millilitres of diluted sample was distilled with 20 ml of 40 per cent sodium hydroxide using Micro Kjeldhal distillation unit (KelplusDistyl-EMBA, Pelican Equipment, Chennai). Steam was distilled over 2 per cent boric acid (5ml) containing mixed indicator (1 part 0.2 per cent methyl red + 2 parts 0.2 per cent bromocresol green dye in ethanol) for collecting 35 ml of distillate. The ammonia trapped in boric acid was determined by titrating with 0.1 N sulphuric acid. The nitrogen percentage was calculated using the following formula.

$$\text{Nitrogen (\%)} = \frac{(\text{A}-\text{B}) \times 0.0014 \times \text{Total volume made}}{\text{Weight of sample taken} \times \text{Volume distilled}} \times 100$$

A= Titrated value for sample

B= Titrated value for blank

Protein percentage was determined by conversion of nitrogen to protein by using conversion factor (6.25), assuming that all the nitrogen in meat was present as protein *i.e.* protein (%)= Nitrogen (%) × conversion factor .

3.4.4. Ash

Ash percentage was determined by gravimetric method as described by AOAC (2016) using muffle furnace (Rotek, Mumbai). Accurately weighed ground sample (around 10 g) was transferred to pre weighed crucible, charred on a hot plate at 100 °C for 30 min and transferred to muffle furnace at 550 °C for 5 h. The sample was then transferred to desiccator having fused calcium chloride as desiccant. After 1 h the crucible was weighed. The ash content was calculated by the following formula.

Weight of ash

$$\text{Ash (\%)} = \frac{\text{-----}}{\text{Weight of sample taken}} \times 100$$

Weight of sample taken

3.4.5. Carbohydrate

Carbohydrate content was calculated by subtracting the sum of moisture, protein, fat and ash contents from 100.

$$\text{Carbohydrate (\%)} = 100 - (\text{Moisture \%} + \text{Fat \%} + \text{Protein \%} + \text{Ash \%})$$

3.5. MICROBIOLOGICAL PARAMETERS

All the microbiological parameters were determined by following standard methods of American Public Health Association. Readymade media (Hi-Media and Sisco Research Laboratories, India) were used for all the microbiological examinations.

3.5.1. Preparation of Serial Dilution

Laminar flow chamber (Rotek, Mumbai) was pre-sterilised by ultra-violet radiation for 20 min before use. Ten grams of sample was aseptically weighed and transferred to a pre-sterilised stomacher bag with 90 ml of sterile 0.1 per cent peptone (Hi-Media) water and stomached in a stomacher (499 circulator, Seward, U.K) for 1 min at the speed of 20. One millilitre of this 10^{-1} dilution was transferred to 9 ml of sterile 0.1 per cent peptone water in a test tube and mixed uniformly to get 10^{-2} dilution. One millilitre of 10^{-2} dilution was added to 9 ml of peptone water and mixed to obtain 10^{-3} dilution and so on until serial dilution was made as per requirement.

3.5.2. Aerobic Plate Count

Aerobic plate count (APC) was evaluated as per the procedure of Morton (2001). In 1000 ml of distilled water, 30 g of Plate count agar (Hi media M091, Mumbai) was suspended, boiled to dissolve the agar completely, and sterilised by autoclaving at 121°C and 15 pounds pressure for 15 min. The final pH of the medium was adjusted to 7.0 ± 0.02 at 25°C . Duplicate sets of sterilised Petri-dishes were inoculated aseptically with 1ml of aliquots from appropriate dilutions. About 15 ml of agar, melted and maintained at 45°C was poured gently in to each dish and rotated in clockwise and anticlockwise

directions for 3 sec to mix the media uniformly. The plates were incubated at 35 °C for 48 h. After incubation, plates were examined for colony formation.

3.5.3. Anaerobic Plate Count

In 1000 ml of distilled water, 30 g of Plate count agar (Hi media M091, Mumbai) was suspended, boiled to dissolve the agar completely, and sterilised by autoclaving at 121 °C and 15 pounds pressure for 15 min (Lake *et al.*, 2001). The final pH of the medium was adjusted to 7.0 ± 0.02 at 25 °C. Duplicate sets of sterilised Petri-dishes were inoculated aseptically with 1ml of aliquots from appropriate dilutions. About 15 ml of agar, melted and maintained at 45 °C was poured gently in to each dish and rotated in clockwise and anticlockwise directions for 3 sec to mix the media uniformly. The Petri-dishes were firmly sealed together with Petri-Seal (Diversified Biotech, Inc., Massachusetts). Sealed Petri-dishes were then stacked in a jar with lid in which anaerobic condition was generated by lighting candles inside. The plates were incubated at 37 °C for 48 h. After incubation, plates were examined for colony formation.

3.6. SENSORY ATTRIBUTES

Sensory evaluation of samples of chicken *biryani* was conducted by a semi-trained panel consisting of six panelists for each trial, drawn from the department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode using an eight-point Hedonic score card as presented in Annexure (Badr *et al.*, 2004) The attributes evaluated were colour, flavour, texture, odour and overall acceptability.

3.7. COMMERCIAL STERILITY

The samples processed at different F_0 value and at different temperatures were incubated at 37°C for 15 days and 55°C for minimum of 5 days. The incubated pouches were aseptically opened and 1 to 2 g of the samples were taken by a sterilized forceps and inoculated into the sterilized fluid thioglycolate broth in test tubes. Sterilized liquid paraffin was put on to the top of the broth to create anaerobic condition and incubated at 37°C for 48 h and at 55°C for 5 days.

3.8. COST OF PRODUCTION

Cost of production of retort processed traditional chicken *biriyani* in flexible pouch was calculated for one packet of 200 g based on the cost of production.

3.9. STATISTICAL ANALYSIS

The data obtained were statistically analysed by repeated measures ANOVA followed by least significant difference, Wilcoxon signed rank test and Friedman test using SPSS software (VERSION 21) as per Snedecor and Cochran (1994).

4. RESULTS

Retort pouch processed traditional chicken *biriyani* was subjected to physico-chemical, microbiological and sensory quality analyses on the day of preparation (day 0), 30th day, 60th day, 90th day and 120th day. Preliminary trials of standardisation of chicken *biriyani* showed that rice:water combination of 1:1 was optimum based on sensory evaluation. Also, soaking time of 15 minutes was observed to be ideal based on sensory evaluation and texture profile analysis.

4.1. PHYSICAL PROPERTIES OF RETORT POUCH

Different tests were carried out on the retort pouches to assess the physical characters including thickness, tensile strength, elongation at break and heat seal strength using the Universal Testing Machine. The results are depicted in Table 3. Tensile strength is the pressure that is employed in resisting rupture and breakage, when tensile forces act on the pouches and it was found to be greater in machine direction (MD) than in cross direction (CD). Heat seal strength, which is an important property related to the integrity of the pouches was found to be higher in machine direction than in cross direction.

4.2. RETORT PROCESSING

4.2.1. Heat Penetration Characteristics

The preliminary trials conducted suggested that processing the product at F_0 3.5 provided the product with good sensorial and textural characters. So, the processing of chicken *biriyani* was done at F_0 3.5 and the heat penetration characteristics of chicken and rice are presented in Table 4. The come up time to attain 121 °C amounted to 5 min. The heating rate index, f_h value was 18 min and the process time (B) was 26.17 min in case of rice. The total process time (T) of rice came to 29.07 min, which was calculated by adding heating value of come up time (58%) to B. The heating lag factor (J_h) and the cooling lag factor (J_c) in case of rice was 1.175 and 1.02, respectively. The time in minutes for sterilization (U) was found to be 5.73 and g value, which is the final temperature deficit at the end of heating, was 3.44 for rice. The f_h value was 20 min and U value was 2.65 min for chicken. Process time (B) and

total process time (T) for chicken came up to 25.82 min and 28.72 min, respectively. Heating and cooling lag factors, J_h and J_c were 1.66 and 1.01, respectively and g value was 7.15.

4.2.2. Sterility Test

The sterility test conducted on the four packets of retort processed chicken *biriyani* was found to be satisfactory and the samples were sterile after processing.

4.3. PHYSICO-CHEMICAL CHARACTERISTICS

4.3.1. pH

pH of retort pouched chicken *biriyani* is given in Table 5. A significant difference ($p < 0.01$) was noticed in the pH values of the product between storage days. The highest pH value was observed in the product on day 0 and the value reduced during storage, with the lowest value on day 120.

4.3.2. Thiobarbituric Acid Reactive Substances (TBARS) Number

TBARS number of retort pouched chicken *biriyani* is given in Table 5. Thiobarbituric acid reactive substances number increased significantly ($p < 0.01$) as the storage days progressed. The value was highest on 120th day and lowest on 0th day.

4.3.3. Tyrosine Value

Tyrosine values of the samples are given in Table 5. A significant difference ($p < 0.01$) in the value was observed in the product between different days of storage. The highest value was observed on 120th day and lowest value on 0th day.

4.3.4. L* a* b* Colour Values

L*, a* and b* colour values of the product during storage are shown in Table 6. The difference in L* values of the product between different storage days was found to be significant ($p < 0.01$). Lightness value reduced significantly ($p < 0.01$) only on day 90 and thereafter it remained constant till day 120.

a* values reduced progressively as the storage progressed and it showed significant ($p<0.01$) difference. The highest value was exhibited on the 0th day and lowest on 120th day.

Significant ($p<0.01$) difference was noted in the case of b* values during storage study. The value significantly ($p<0.01$) increased on day 30 and thereafter it reduced on day 60 and again increased significantly ($p<0.01$) on day 120.

4.4. PROXIMATE PRINCIPLES

The analyses of proximate principles including moisture, fat, protein and ash were done on 0th, 30th, 60th, 90th and 120th days of storage. Carbohydrate content was found out by calculation by subtracting the sum of all other proximate values from 100. The result of proximate analysis is given in Table 7.

Moisture content of the samples increased significantly ($p<0.01$) over the storage period. The highest value was observed on 120th day and lowest on 0th day.

Fat content of the samples decreased significantly ($p<0.01$) over the storage period. The value significantly ($p<0.01$) reduced on days 30 and 60 and thereafter it remained constant till day 120.

Protein content of the samples decreased significantly ($p<0.01$) over the storage period. The value significantly ($p<0.01$) reduced on days 30 and 60 and thereafter it remained constant till day 120.

Ash per cent varied significantly ($p<0.01$) over the storage period and the value increased on storage.

Carbohydrate content did not show any significant difference during the storage period.

4.5. MICROBIOLOGICAL PARAMETERS

4.5.1. Aerobic Plate Count

The product was subjected to aerobic plate count assay on days 0, 30, 60, 90 and 120 of storage. The incubated plates upon examination revealed an absence of bacterial colonies throughout the storage period.

4.5.2. Anaerobic Plate Count

The product was subjected to analysis of anaerobic plate count on days 0, 30, 60, 90 and 120 of storage. No colonies were detected in any of the plate during storage.

4.6. SENSORY ATTRIBUTES

Six membered semi trained panel drawn from the department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode conducted the sensory evaluation of the product, on days 0, 30, 60, 90 and 120 of storage. The sensory attribute scores of the product are detailed in Table 8.

Colour scores showed significant decrease ($p < 0.01$) throughout the storage period. The highest score was observed on 0th day and the lowest score on 120th day.

A significant ($p < 0.01$) decrease in flavour score was observed as storage advanced. The highest score was recorded on day 0 and lowest score on 120th day.

Scores for texture varied significantly ($p < 0.01$) as the storage progressed. The score significantly ($p < 0.01$) reduced from day 60 onwards, however, the scores of day 90 and 120 were similar.

Odour scores showed significant difference ($p < 0.01$) across storage. A significant decrease was observed on day 30 and day 60 and thereafter it remained constant.

Overall acceptability score reduced significantly ($p < 0.01$) on storage on day 60 and thereafter it remained constant.

4.7. COST OF PRODUCTION

The total cost of production for a 200 g packet of retort processed traditional chicken *biriyani* came to Rs. 53. After taking into consideration the cost of processing ingredients, operational cost and labour charge The operational cost and labour charge per packet was Rs. 10. The flexible retort pouches were purchased for Rs. 5 per piece.

5. DISCUSSION

Traditional chicken *biriyani* was prepared using boneless breast meat of broiler chicken, rice, spices and condiments, using the recipe obtained from home-makers, cooks and from preliminary trials conducted in the department. The preparation was then packed in flexible retort pouches of 200 g capacity and retort processing was done using steam-air retort. The samples for sterility testing were incubated at 37°C for 15 days and 55°C for a minimum of 5 days, and rest of the sample packets were stored at room temperature for analysis. The stored samples were then subjected to physico-chemical, microbiological and sensory quality analyses on days 0, 30, 60, 90 and 120.

5.1. PHYSICAL PROPERTIES OF RETORT POUCH

Retortable pouches used in the study had three layer configuration of 12 μ PET ALO_x (aluminium oxide coated polyester film), 15 μ nylon and 70 μ cast polypropylene and the size was found to be 16 X 18cm. Properties such as tensile strength, elongation at break and heat seal strength of the pouch was found to be more when measured in machine direction than in cross direction. This was in accordance with the findings of Rajkumar *et al.* (2010) during the study of retort pouch processed *Chettinad* style goat meat curry. Lakshmana *et al.* (2013) also found a similar result while studying the properties of retort pouch processed tender jackfruit curry. The pouches used by Chandrasekar and Gopal (2008) for the study of retort pouch processed mushroom curry revealed similar results.

5.2. RETORT PROCESSING

5.2.1. Heat Penetration Characteristics

The product was processed at an F_0 3.5 and the come up time was 5 min, which was sufficiently of a short duration (NCA, 1968). During the retort pouch processing of mushroom curry, Chandrasekar and Gopal (2008) found that come up time was 5.5 min. The heating rate index, f_h value was found to be 18 min and the process time (B) was 26.17 min in case of rice. The total process time (T) of rice came to 29.07 min, which was arrived by adding heating value of come up time (58%) to B. The heating lag factor (J_h) and the cooling lag factor (J_c) in case of rice were 1.175 and 1.02, respectively. The time in minutes for sterilization (U) was found to be 5.73 min and g value, which is the final temperature deficit at the end of heating was 3.44 for rice.

The f_h value was 20 min and U value was 2.65 min for chicken. Process time (B) and total process time (T) for chicken came up to 25.82 min and 28.72 min, respectively. Heating and cooling lag factors, J_h and J_c were 1.66 and 1.01, respectively and g value was 7.15. Lavanya *et al.* (2016) processed mutton *kheema biriyani* to an F_0 of 6.09. They stated that come up time to attain 121 °C was 10 min and the total process time came up to 34 min. When Bindu *et al.* (2007) processed ready-to-eat black clam in retort pouches, f_h value was 21.5 min and B value was 35.4 min. J_h and J_c were 0.965 and 1.194, respectively. g and U values were 3.1368 and 9, respectively.

5.2.2. Sterility Test

The sterility test conducted on the samples of retort processed chicken *biriyani* was found to be satisfactory and the samples were sterile after processing. Lakshmana *et al.* (2013) stated that retort pouch processed tender jackfruit curry was commercially sterile on sterility testing. Bindu *et al.* (2010) analysed the commercial sterility of ready-to-eat fish *peera* in retort pouches and found an absence of turbidity in the test tubes, indicating sterility of samples.

5.3. PHYSICO-CHEMICAL CHARACTERISTICS

5.3.1. pH

pH decreased significantly ($p < 0.01$) as the storage days progressed. Highest and lowest pH values were observed on day 0 and day 120, respectively. The decrease may be due to lipid oxidation and protein degradation of meat as well as degradative changes occurring in rice resulting in the production of acidic metabolites, causing a lowering of pH. This was in accordance with Jang and Lee (2012), who concluded that the decreasing pH value in ready-to-eat ginseng chicken porridge was due to the process of oxidation of the lipids present in the product. Devadason *et al.* (2014) noticed a gradual decline of pH of the buffalo meat blocks processed in retort pouches, that was stored for three months. Bindu *et al.* (2010) also noticed a significant decrease in pH over storage period of 12 months in retort processed fish *peera*.

5.3.2. Thiobarbituric Acid Reactive Substances (TBARS) Number

TBARS number represents the lipid peroxidation in a product and it shows the degree of oxidative rancidity in the product. Significant ($p < 0.01$) increase was observed

in TBARS number on storage. The lowest and highest values were registered on 0th day and 120th day, respectively. This increase on storage can be attributed to the lipid peroxidation occurring in the product as storage days increased. The increase in TBARS number is expected and agreed with the findings of Lavanya *et al.* (2016), who reported that the free fatty acids and TBARS increased with increasing storage time in mutton *kheema biriyani*. Girish *et al.* (2018) noticed a significant increase in TBARS number in shelf stable ready-to-eat pork curry during storage. Similarly, a significant increase in TBARS was reported by Thakur and Rai (2018), in retort processed ready-to-eat rice *pulav*, during the storage period.

5.3.3. Tyrosine Value

Significant ($p < 0.01$) increase in tyrosine value was recorded during the storage period of the product. The highest value was noticed on 120th day and lowest value on 0th day. This increase was in accordance with the study conducted by Nalini *et al.* (2018) who reported significant increase in tyrosine value during the 90 days storage study of retort processed pepper chicken. Devadason *et al.* (2014) found that retort pouch processed buffalo meat blocks showed significant increase in tyrosine value on storage and concluded that the increase indicated proteolysis. Tyrosine value manifested significant increase during the storage period of 180 days in retort processed *Chettinad* chicken curry (Rajan, 2014).

5.3.4. L* a* b* Colour Values

The L* (lightness or the darkness of the product) values of the product differed significantly ($p < 0.01$) between the storage days. It was registered that lightness value reduced significantly ($p < 0.01$) only on day 90 and thereafter it remained constant till day 120. Rajkumar *et al.* (2010) observed reduced L* values in retort processed *Chettinad* style goat meat curry and proposed that it could be due to the Maillard reaction taking place during retorting, resulting in darker product. In retort pouch packed *Chuncheon Dakgalbi*, a chicken based Korean dish, the lightness values (L*) when stored at room temperature increased during the first two weeks of storage and then reduced significantly on the third week of storage (Muhlisin, 2013). A significant decrease in L* values was reported by Nalini *et al.* (2018) in retort processed pepper chicken during a storage period of 90 days.

The a^* (redness or greenness) values significantly ($p < 0.01$) reduced as the storage progressed. This finding agreed with the study of Jang and Lee (2012), who evaluated ready- to- eat ginseng chicken porridge and found that there was significant decrease in a^* values. Lavanya *et al.*, (2016) reported a decrease in a^* values in retort processed mutton *kheema biriyani* during a storage period of sixty days. Zarim *et al.* (2021) also recorded a significant decrease in a^* values of retort processed texture-modified chicken rendang and they were of the opinion that it could be due to degradation of β -carotene pigments, as well as the formation of brown pigments due to Maillard reaction.

Significant ($p < 0.01$) difference was noted in the case of b^* values during storage study. The value significantly ($p < 0.01$) increased on day 30 and thereafter it reduced on day 60 and again increased significantly ($p < 0.01$) till day 120. Dinakaran and Panda (2017) reported a similar result in ready-to-eat cassava packed in see through pouches. They found an increase in b^* values throughout the storage period of 120 days. Significant increase in b^* values were also found by Jang and Lee (2012) in ready-to-eat *ginseng* porridge during a storage period of 28 weeks.

5.4 PROXIMATE PRINCIPLES

It was found that the moisture content of the product increased significantly ($p < 0.01$) during the storage study. While studying the proximate composition of retort processed mutton *kheema biriyani*, Lavanya *et al.* (2016) observed a non-significant increase in moisture content of the product. Lakshmana *et al.* (2013) registered an increase in moisture content of retort pouch processed ready-to-eat tender jackfruit curry, during the storage period of 12 months. Praharasti *et al.* (2019) reported a significant increase in moisture content of beef rendang inside retort pouch packaging stored at different temperatures.

Fat content of the samples decreased significantly ($p < 0.01$) over the storage period. This might be due to the increase in moisture content, which led to a decrease in fat percentage. The result was in accordance with the study of Lavanya *et al.* (2016) who studied the proximate composition of retort processed mutton *kheema biriyani* and found a significant decrease in fat content. While studying the proximate composition of retort

pouch processed ready-to-eat tender jackfruit curry, Lakshmana *et al.* (2013) reported a decrease in fat content as storage period advanced.

Protein content of the samples decreased significantly ($p < 0.01$) over the storage period, which might be due to an increase in moisture content. It was observed that the value significantly ($p < 0.01$) reduced on days 30 and 60 and thereafter it remained constant until day 120. Gobikrishnan *et al.* (2019) reported a similar result in case of retort processed traditional rice dumpling. They observed a decrease in protein content of the product throughout the storage period. Lavanya *et al.* (2016) reported a decrease in protein content of retort processed mutton *kheema biriyani* during the storage study.

Ash per cent was found to increase significantly ($p < 0.01$) over the storage period and the value increased on storage.

Carbohydrate content did not show any significant difference during the storage period. Lakshmana *et al.* (2013) also reported that carbohydrate per cent did not change significantly during the storage study of retort pouch processed ready-to-eat tender jackfruit curry.

5.5. MICROBIOLOGICAL PARAMETERS

5.5.1. Aerobic Plate Count

When the product was subjected to aerobic plate count assay, incubated plates revealed an absence of bacterial colonies throughout the storage study. This result agreed with the findings of Shah *et al.* (2017), who analysed *Rogan josh* in retort pouches for total plate count. They reported an absence of microbial growth during the storage period and concluded that the temperature applied during the processing as well as the sterility maintained inside the packets could be the reason behind this. Coliforms, yeast and mould and *Staphylococcus* were absent in retort packaged *Chettinad* goat meat over the storage period of ten months (Rajkumar *et al.*, 2010). Rajan *et al.* (2014) reported an absence of *E. coli*, *Salmonella spp.* and *Staphylococci spp.* in retort packaged *Chettinad* chicken during the entire storage period.

5.5.2. Anaerobic Plate Count

When the product was subjected to analysis of anaerobic plate count no colonies were detected in any of the plate during storage period. Zarim *et al.* (2021) reported an absence of anaerobic bacteria during 6 months of storage in retort packaged texture-modified chicken rendang using xanthan gum. Rajan *et al.* (2014) stated that *Chettinad* chicken processed in retort pouch was free of anaerobe colonies. Retort packaged buffalo meat blocks were found to be completely free of anaerobes during the entire storage study period (Devadason *et al.*, 2014).

5.6. SENSORY ATTRIBUTES

A significant ($p < 0.01$) decrease in colour scores was observed throughout the storage period. This was in accordance with the result of Devadason *et al.* (2014) who reported a significant reduction in colour scores of buffalo meat blocks in retort pouches as storage time increased. Kumar *et al.* (2013) observed a significant decrease in colour score of chicken *pulav* stored under ambient condition as well as at 45 °C. Shah *et al.* (2017), when analysing sensory attributes of *Rogan Josh*, a Kashmiri meat product, registered a significant decrease in appearance scores throughout the storage period.

As storage advanced, a significant ($p < 0.01$) decrease in flavour score could be observed in the product. Bindu *et al.* (2010) when studying changes in sensory scores of retort processed fish *peera*, observed significant decrease in flavour scores. Shah *et al.* (2017) also found a significant decrease in flavour scores of *Rogan Josh* stored for a year. Kumar *et al.* (2015) observed a non-significant decrease in flavour scores of retort packaged egg curry and egg *burji* stored under ambient temperature (27-30°C) and accelerated temperature (45°C) for 12 months.

Texture scores reduced significantly ($p < 0.01$) as the storage progressed. Similar results were observed by Lavanya *et al.* (2016) who reported a decrease in texture scores of retort packaged mutton *kheema biriyani*. After 12 months of storage Bindu *et al.* (2010) reported a significant decrease in texture scores of retort processed fish *peera*. Kumar *et al.* (2015) when studying sensory scores of retort packaged egg curry and egg *burji* reported a decrease in texture scores throughout the storage period under ambient temperature (27-30°C) and accelerated temperature (45°C).

Odour scores showed significant reduction ($p<0.01$) across storage period. Lavanya *et al.* (2016) reported a significant decrease in odour scores of retort packaged mutton *kheema biriyani* throughout the storage period. Bindu *et al.* (2010) also noticed a significant decrease in odour scores of retort processed fish *peera* during storage.

Overall acceptability score showed a significant reduction ($p<0.01$) on day 60 of storage and thereafter the scores did not show a notable change. Dinakaran and Panda (2017) reported similar results in case of ready-to-eat cassava packaged in see-through retort pouches, where they found significant decrease in overall acceptability scores across a storage period of 12 months. Lavanya *et al.* (2016) reported a non-significant reduction in the acceptability of retort packaged mutton *kheema biriyani* over a storage period of 2 months. Bindu *et al.* (2010) reported significant decrease of acceptability scores of retort processed fish *peera* during storage.

5.7. COST OF PRODUCTION

The total cost of Rs. 53 per packet included the price of chicken, cost of spices, condiments and rice, operational charges, labour cost and cost of the packaging material. The total cost could be further reduced in a large scale production facility.

6. SUMMARY

Traditional dishes are a favourite among many people. Such dishes have a long history. In India, due to its vast geographical and cultural heritage, many traditional dishes are in existence and chicken *biriyani* is one among the many such dishes that is relished by many. Traditional chicken *biriyani* of Kerala is a combination of rice and chicken infused with a balanced spice blend. In Malabar, every special occasion demands biriyani and instead of *basmati* rice, traditional preparation uses *Kaima* rice. This rice variety is produced by the local farmers of Wayanad district of Kerala. Even though biriyani is liked by many, the long cooking process makes it difficult to prepare. The lifestyle of the urban people with nuclear families and busy schedules is very demanding and they require an easy solution for satisfying appetite as well as the nutritional requirements of the family. Urbanisation had also influenced the consumption pattern of meat. Increased income of the urban class leads to an increased consumption of meat and other protein rich foods. Thermally processed shelf-stable foods that are safe, healthy and easy to prepare are an alternative for such kind of people. The food processing industry has shown significant growth following urbanisation and outlets supplying processed foods and meat have increased in India over time. Thermal processing and ready-to-eat shelf stable foods are slowly gaining popularity especially in areas where it is difficult to maintain cold chain facilities and during journeys.

Thermal processing focuses to eliminate pathogenic as well as spoilage microbes by subjecting the food to a specific time-temperature combination. In canning, a popular thermal processing method, the sealed chamber of the can acts as a sterile environment and prevents further contamination. Retort pouches are flexible pouches made of laminates of plastics and metals and they work on the same principle. In India, a variety of traditional vegetarian foods, curries etc. processed in retort pouches are available commercially in different kinds of pouches such as pillow type pouches, stand up pouches, pouches with zipper and pouches with spout. In this background a study was conducted at Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode and Fish Processing Division, ICAR- Central Institute of Fisheries Technology, Kochi and, to standardise and optimise processing conditions of traditional chicken *biriyani* and assess the quality, so that more ready-to-eat traditional food products are available for the food consumers. Broiler chicken, rice, spices and

condiments were obtained from local markets. The boneless breast meat of broiler chicken was blanched in 6% saline solution for four minutes. The spice mix used in the biriyani was made from dry roasting and grinding cinnamon, clove, cardamom, pepper, fennel seeds and cumin seeds. After sautéing cinnamon, cardamom and cloves in ghee in a pan, the rice that was soaked for 15 minutes and drained, was added and sautéed for 2 minutes. The chicken *masala* was prepared by cooking chicken with onion, ginger-garlic paste, green chilli, mint leaves, coriander leaves, prepared *biriyani* spice mix and tomato in oil. A retortable flexible pouch of 3-layer configuration, consisting of outer (12 μ) PET ALO_x, middle layer made of nylon with thickness 15 μ and inner cast polypropylene of 70 μ thickness was used for the study and various mechanical parameters such as thickness, tensile strength, elongation at break and heat seal strength were analysed to determine the suitability of these containers for thermal processing. Eighty grams of the prepared chicken masala, 50 grams of rice and 50 grams of hot water were filled in each of the retort pouch manually. Exhausting and sealing of the pouches were done immediately after filling of the pouches. The pouches were processed in a steam-air retort at 121.1⁰C with an Fo value of 3.5. The product was then subjected to physico-chemical, microbiological and sensory qualities on the day of preparation (day 0), 30th, 60th, 90th and 120th day.

Tensile strength, elongation at break and heat seal strength of the pouches were found to be greater in machine direction than in cross direction. Thickness of the pouch was 115 microns.

The come up time to attain 121 °C amounted to 5 min The heating rate index, f_h value was 18 min and the process time (B) was 26.17 min in case of rice. The total process time (T) of rice came to 29.07 min. The heating lag factor (J_h) and the cooling lag factor (J_c) in case of rice were 1.175 and 1.02, respectively. The time in minutes for sterilization (U) was found to be 5.73 and g value, the final temperature deficit at the end of heating, was 3.44 for rice. The f_h value was 20 min and U value was 2.65 min for chicken. Process time (B) and total process time (T) for chicken came up to 25.82 min and 28.72 min, respectively. Heating and cooling lag factors, J_h and J_c were 1.66 and 1.01, respectively and g value was 7.15. Also, the sterility test conducted on the products was found to be satisfactory.

pH decreased significantly ($p < 0.01$) as storage advanced. The highest pH value was observed in the product on day 0 and the lowest value on day 120. Thiobarbituric acid reactive substances number increased significantly ($p < 0.01$) as the storage days progressed. The value was highest on 120th day and lowest on 0th day. A significant increase ($p < 0.01$) in the tyrosine value was observed in the product between different days of storage. The highest value was observed on 120th day and lowest value on 0th day. Lightness (L^*) value reduced significantly ($p < 0.01$) only on day 90 and thereafter it remained constant till day 120. a^* values reduced progressively as the storage progressed and it showed significant ($p < 0.01$) difference. The highest value was exhibited on the 0th day and lowest on 120th day. The b^* value significantly ($p < 0.01$) increased on day 30 and thereafter it reduced from day 60 and again increased significantly ($p < 0.01$) on day 120.

Moisture content of the samples increased significantly ($p < 0.01$) over the storage period. The highest value was observed on 120th day and lowest on 0th day. Fat content of the samples decreased significantly ($p < 0.01$) over the storage period. The value significantly ($p < 0.01$) reduced on days 30 and 60 and thereafter it remained constant till day 120. Protein content of the samples also showed a similar decrease over the storage period. The value significantly ($p < 0.01$) reduced on days 30 and 60 and thereafter it remained constant till day 120. Ash per cent varied significantly ($p < 0.01$) over the storage period and the value increased on storage. Carbohydrate content did not show any significant change during the storage period.

The plates incubated for aerobic and anaerobic bacteria revealed an absence of bacterial colonies throughout the storage period.

Colour scores showed significant decrease ($p < 0.01$) throughout the storage period. The highest score was observed on 0th day and the lowest score on 120th day. A significant ($p < 0.01$) decrease in flavour score was observed as storage advanced. The highest score was recorded on day 0 and lowest score on 120th day. Scores for texture varied significantly ($p < 0.01$) as the storage progressed. The score significantly ($p < 0.01$) reduced from day 60 onwards, however, the scores of days 90 and 120 were similar. Odour scores showed significant difference ($p < 0.01$) across storage. A significant decrease was observed on day 30 and day 60 and thereafter it remained constant. Overall

acceptability score reduced significantly ($p < 0.01$) on storage on day 60 and thereafter it remained constant.

The total cost of production for a 200 g packet of retort processed traditional chicken biriyani came to Rs. 53.

From the results it can be concluded that the retort processed chicken biriyani was shelf-stable at ambient temperature for 120 days. The highly perishable, traditional product was sterile and highly acceptable on all days of storage study and can be economical when produced in mass. It can be said that retort packaging is one of the most significant advancements in food packaging after the innovation of canning and the most suitable processing method for the busy lifestyle of today.

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ANNEXURE
SENSORY SCORE CARD

Name:
Experiment No.:

Product:
Date:

Attributes	Scale of descriptive attribute of product							
	8	7	6	5	4	3	2	1
Colour	Excellent	Very good	Good	Fair	Slightly poor	Moderately Poor	Very poor	Extremely poor
Flavour	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Texture /Doneness	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Odour	Extremely pleasant	Very pleasant	Moderately pleasant	Slightly Pleasant	Slightly unpleasant	Moderately unpleasant	Very unpleasant	Extremely unpleasant
Over all acceptability	Extremely acceptable	Very acceptable	Moderately acceptable	Slightly acceptable	Slightly unacceptable	Moderately unacceptable	Very unacceptable	Extremely unacceptable

Attributes	Sample 1	Sample 2	Sample 3	Sample 4
1. Colour				
2. Flavour				
3. Texture /Doneness				
4. Taste				
5. Odour				
6. Overall acceptability				

Remarks:

Signature & Date:

**QUALITY OF RETORT POUCH PROCESSED TRADITIONAL CHICKEN
*BIRIYANI***

NAMRATHA VALSALAN

(19-MVP-20)

THESIS ABSTRACT

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF VETERINARY SCIENCE

(Livestock Products Technology)

2022

**Faculty of Veterinary & Animal Sciences
Kerala Veterinary and Animal Sciences University**



DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY

COLLEGE OF VETERINARY AND ANIMAL SCIENCES

POOKODE, LAKKIDI P. O., WAYANAD 673 576

KERALA, INDIA

ABSTRACT

The study entitled “Quality of retort pouch processed traditional chicken *biriyani*” was carried out at Fish Processing Division, ICAR- Central Institute of Fisheries Technology, Kochi and Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode. The objectives were to optimise the retort processing conditions of traditional chicken *biriyani*, evaluate the physico-chemical, microbiological and sensory attributes of the product and assess the shelf-life of the retorted product. Chicken, rice, spices and condiments were obtained from local markets and retort pouch processing of traditional chicken *biriyani* was done using the steam-air retort of ICAR-CIFT, Kochi. The product was subjected to physico-chemical, microbiological and sensory qualities on the day of preparation (day 0), 30th, 60th, 90th and 120th day. The product was processed at an F_0 3.5 and the come up time was 5 minutes. The heating rate index, f_h value was found to be 18 min and the process time (B) was 26.17 min in case of rice. The total process time (T) of rice came to 29.07 min. The heating lag factor (J_h) and the cooling lag factor (J_c) in case of rice were 1.175 and 1.02, respectively. The time in minutes for sterilization (U) was found to be 5.73 min and g value, which is the final temperature deficit at the end of heating was 3.44 for rice. The f_h value was 20 min and U value was 2.65 min for chicken. Process time (B) and total process time (T) for chicken came up to 25.82 min and 28.72 min, respectively. Heating and cooling lag factors, J_h and J_c , were 1.66 and 1.01, respectively and g value was 7.15. The sterility test conducted on the samples of retort processed chicken *biriyani* was found to be satisfactory and the samples were found sterile after processing. There was a significant decrease in pH ($p < 0.01$) as the storage days progressed. Significant ($p < 0.01$) increase was observed in TBARS number on storage. The lowest and highest values were registered on 0th day and 120th day, respectively. This increase on storage can be attributed to the lipid peroxidation occurring in the product as storage days increased. Tyrosine value showed significant ($p < 0.01$) increase during the storage period of the product, which pointed to the proteolysis that happens during long term storage. The L^* (lightness or the darkness of the product) values of the product differed significantly ($p < 0.01$) between the storage days. It was registered that lightness value reduced significantly ($p < 0.01$) only on day 90 and thereafter it remained constant till day 120. The a^* (redness or greenness) values significantly ($p < 0.01$) reduced as the storage progressed. Significant

($p < 0.01$) difference was noted in the case of b^* values during storage study. The value significantly ($p < 0.01$) increased on day 30 and thereafter it reduced on day 60 and again increased significantly ($p < 0.01$) till day 120. The moisture content of the product increased significantly ($p < 0.01$) during the storage study. Fat and protein per cents of the samples decreased significantly ($p < 0.01$) over the storage period. Ash per cent was found to increase significantly ($p < 0.01$) over the storage period and it was observed that carbohydrate content did not show any significant difference during the storage period. The product was subjected to aerobic as well as anaerobic plate counts and the incubated plates revealed an absence of bacterial colonies throughout the storage study of 120 days. When the sensory analysis was performed, a significant decrease in colour, odour, flavour, texture and overall acceptability scores was recorded. The cost of retort processed traditional chicken *biriyani* was Rs. 53 per packet and it included the price of chicken, cost of spices, condiments and rice, operational charges, labour cost and cost of the packaging material.

KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY
Faculty of Veterinary and Animal Sciences
PROGRAMME OF RESEARCH WORK FOR THESIS FOR MASTERS DEGREE

- | | |
|---|---|
| <p>1. Title of thesis
Quality of retort pouch processed traditional chicken biriyani</p> <p>2. a) Title of the departmental/KVASU research project of which this forms a part
Nil</p> <p>b) Code No. if any, and order by which the departmental/KVASU research project is approved
Not applicable</p> <p>3. a) Name of student
Namratha Valsalan</p> <p>b) Admission No
19-MVP-20</p> <p>c) Name of the discipline
Livestock Products Technology</p> <p>4. a) Name of Major advisor
Dr. Renuka Nayar</p> <p>b) Address
Associate Professor
Department of Livestock Products Technology
College of Veterinary and Animal Sciences, Pookode, Lakkidi P.O., Wayanad</p> <p>5. Objectives of the study</p> | <p>1. Optimise the retort processing of traditional chicken biriyani</p> <p>2. Evaluate the physico-chemical, microbiological and sensory attributes of the product</p> <p>3. Assess the shelf-life of the retorted product</p> <p>6. Practical/ Scientific utility
Traditional foods represent the cultural heritage and connect to the past of a particular region. Present day consumers prefer traditional foods of high quality which are safely processed and neatly packed. In the present world scenario of changing lifestyle, increased work pressure and nuclear families, the demand for ready-to-eat processed foods has increased, even in developing countries like India. Thermal processing is one of the most effective means of preserving food and it can be used to enhance the shelf life of food products. Retorted products in pouches are accepted more than</p> |
|---|---|

canned foods in India. Retort pouches could be imprinted, their size and shape are flexible and can be easily displayed on shelves. Also, food can be cooked faster in flexible pouches than in cans and it helps in reducing the cost of delivery and storage.

Retort processing of the traditional chicken biriyani will help in converting a perishable product into a shelf stable one which can be stored at ambient temperature and consumed as and when required. It also helps in transporting this product to other states or export to outside India where this will be relished by consumers of varied origin and will also help in popularising the product. This can create conditions for industrial level production and commercialisation of the product creating employment opportunities to entrepreneurs.

7. Important publications on which the study is based

The retort pouch package was invented for the US military to substitute for the traditional cans and is now widely used in food industry for long shelf life products (Mirzaei *et al.*, 2006).

Retort processed foods in pouches are more acceptable to consumers than the foods packed in glass and metal containers because of their lighter, more appealing, and convenient end use (Mohan *et al.*, 2006).

Chettinad style goat meat product was processed in retort pouches with F_0 value of 12.1 and cookvalue of 75 min and the packaging material did not impart any undesirable flavour to the product. (Rajkumar *et al.*, 2010).

Kumar *et al.* (2013) noted that total plate count, yeast and mould count, coliform count and spore count (at 37°C and 55°C) were nil, nil, negative, $>10^2$ and $>10^2$ and 1×10^1 , nil, negative, $<10^2$ and $<10^2$ for retort processed chicken *pulav* having $F_0 3$ and irradiated sample (5.0 kGy), respectively, while the combination processed ($F_0 3 + 5.0$ kGy) chicken *pulav* cleared all microbiological tests and were found to be sterile.

A linear and significant increase of tyrosine value from 0.35 to 0.74 mg/100 g was observed with increase of storage period of retort

processed buffalo meat blocks (Devadason *et al.*, 2014).

Gokhale and Lele (2014) developed a semi-empirical unified model which could be used to predict product temperature over a range of process conditions for retort pouch processed products (relative error <10%) such as *Pulav* (steamed rice with vegetables), *Sambar* (south Indian style curry containing mixed vegetables and lentils), *Gajar Halwa* (carrot based sweet product) and *Upma* (wheat based snack product).

Free fatty acid content of retort processed egg curry and egg *burji* increased gradually during storage and the values were higher at storage temperature of 45°C, when compared to storage at 4–5°C and 27–30°C (Kumar *et al.*, 2015).

Majumdar *et al.* (2015) optimised the F_0 value to 7 min for retort processed Calta fish curry with potato and peas.

Freshwater prawn curry was prepared and thermally processed at three different F_0 values, *i.e.*, 6, 8, and 9 and it was observed that sensory textural parameters and instrumental textural parameters showed

decreasing trends as F_0 values increased (Majumdar *et al.*, 2017).

Retort pouch processing is suitable for long term storage of *Rogan josh*, a traditional meat product of Kashmir, at ambient temperature with acceptable quality and safety and thus, will help to increase the market demand for such traditional products due to convenience and ready to eat features (Shah *et al.*, 2017).

Shah *et al.* (2017) observed that thiobarbituric acid reactive substances (TBARS) values increased with increase of storage period from 0 to 12 month in retort processed *Rogan josh*, a traditional meat product of Kashmir.

8. Outline of the technical programme

Chicken biriyani will be prepared using traditional recipe with *Jeerakashala* rice, boneless breast meat of broiler chicken, spices and condiments and will be retorted in retort pouch at Fish Processing Division, ICAR-CIFT, Kochi using steam-air retort (John Fraser and Sons Ltd., New castle upon Tyne, UK). The process conditions like temperature and F_0 value will be optimised using data recorder (Ellab

Co., Rødovre, Denmark) and heat penetration characteristics like lag factors for heating and cooling and process time will be evaluated and standardised based on sensory attributes and sterility test. The product will be subjected to physico-chemical, microbiological and sensory qualities on the day of preparation (day 0), 30th, 60th, 90th, and 120th day or until spoilage, whichever is earlier.

Physico-chemical characteristics viz. pH (AOAC, 2016), thiobarbituric acid (TBA) number (Witte *et al.*, 1970), tyrosine value (Pearson, 1968) and CIELAB L*, a* and b* colour values (Page *et al.*, 2001) will be assessed.

Microbiological qualities viz. sterility test (IS: 2168, 1971), aerobic plate count (Morton, 2001) and anaerobic count (Lake *et al.*, 2001) will also be assessed.

Sensory attributes will be carried out employing a semi-trained panel (Badr, 2004).

The proximate composition with respect to protein, fat and ash as well as carbohydrate and energy values will be assessed on the day of

preparation and moisture on days 0, 30, 60, 90 and 120 or until spoilage, whichever is earlier, as per AOAC (2016).

The techno-economics of the product will be assessed and the data collected will be analysed statistically using SPSS version 24.0.

9. Main items of observations to be made

1. Process variables and heat penetration characteristics

- a. F_0 (min)
- b. Temperature ($^{\circ}$ C)
- c. Lag factor for heating
- d. Lag factor for cooling
- e. Process time (min)

2. Physico-chemical characteristics

- a. pH
- b. Thiobarbituric acid (TBA) number
- c. Tyrosine value
- d. L*, a* and b* colour values

3. Microbiological characteristics

- a. Sterility test (Pass/fail)
- b. Aerobic plate count ($\log_{10}$ cfu/g)
- c. Anaerobic count ($\log_{10}$ cfu/g)

4. Sensory attributes

- a. Colour/appearance

- b. Odour
- c. Taste
- d. Flavour
- e. Doneness
- f. Overall acceptability

Sd/-

Signature of Student

Project coordination group proposed:
Livestock Products Technology
(Group VIII)

5. Proximate principles

- a. Moisture (%)
- b. Protein (%)
- c. Fat (%)
- d. Ash (%)

Pookode,

12-10-2020

Sd/-

Signature of Major advisor

10. Facilities

a) Existing

Laboratory facilities in the Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode, and Division of Fish Processing, ICAR-CIFT, Kochi will be utilised for the study.

b) Additional facilities required

Processing ingredients and chemicals

11. Duration of study

4 semesters

12. Financial estimate

Processing ingredients, chemicals and glasswares: Rs.15,000

Contingencies including analysis:

:Rs.10,000

Total

:Rs.25,000

1. Dr. Sathu T Sd/-

Assistant Professor
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14. Time frame of work

Semester I

1. Collection of literature
2. Preparation of synopsis

Semester II

1. Collection of literature
2. Planning of research work
3. Procurement of chemicals

Semester III

1. Procurement of raw materials
2. Process optimisation
3. Evaluation of the developed product

Semester IV

1. Analysis of data and interpretation of results
2. Compilation and preparation of thesis
3. Submission of thesis

CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to animals (Amendment, 1998).

Pookode
12.10.2020

Sd/-
Major Advisor
Dr. Renuka Nayar

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