



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.23

TPI 2021; 10(5): 211-217

© 2021 TPI

[www.thepharmajournal.com](http://www.thepharmajournal.com)

Received: 10-03-2021

Accepted: 23-04-2021

**Sushant Temgire**

Lovely Faculty of Technology  
and Sciences, Lovely  
Professional University,  
Jalandhar, Punjab, India

**Anjan Borah**

Lovely Faculty of Technology  
and Sciences, Lovely  
Professional University,  
Jalandhar, Punjab, India

**Sandip Kumthekar**

Lovely Faculty of Technology  
and Sciences, Lovely  
Professional University,  
Jalandhar, Punjab, India

**Aniket Idate**

Lovely Faculty of Technology  
and Sciences, Lovely  
Professional University,  
Jalandhar, Punjab, India

**Corresponding Author:**

**Anjan Borah**

Lovely Faculty of Technology  
and Sciences, Lovely  
Professional University,  
Jalandhar, Punjab, India

## Recent trends in ready to eat/cook food products: A review

**Sushant Temgire, Anjan Borah, Sandip Kumthekar and Aniket Idate**

DOI: <https://doi.org/10.22271/tpi.2021.v10.i5c.6207>

### Abstract

Now a day's ready to eat and ready to cook food product have acquired large food market because it is closest replacement to our regular food. Food habits and cooking methods are massively changes in last few years because of urbanization, changes in culture and social modification. We discuss three categories of Ready to eat/cook food products such as based on fruits and vegetables, based on cereals and pulses, based on meat, poultry and fish. Various processing technologies are used for development of this type of food including extrusion, baking, sterilization, puffing, coating, cold plasma, HPP, etc. Packaging and microbial safety of such food products are important to increase shelf life. In this review, we are highlights the recent trends and technologies for development of RTE/RTC food. These types of food are healthy, convenient and accessible but excess intake can be harmful to our health.

**Keywords:** Processing, ready to eat, ready to cook, food, microbial safety, health impact

### 1. Introduction

Food habits and cooking methods in India are massively changes in last few years because of urbanization, changes in culture and social modification. Due to busy life pressure on peoples, they preferred easy and low time consuming cooking methods and quick cooked products <sup>[1]</sup>. The market for ready to eat/cook food products in India are stood at 261million in 2017 and it will be increases and rich at 647 million in 2023 and grow over 16% CAGR rate <sup>[2]</sup>. Modern peoples are changed their lifestyle and behavior towards ready to eat and ready to cook products because number of fast foods are available in market and they are response to the products which are fresh and easy to prepare <sup>[3]</sup>. Ready to eat food products is a category of food which comprised packed food products which used to direct consumption without any cooking where ready to cook food products are needs to some preparations like heating, boiling before consumption.

Consumers are mostly attracted to RTE and REC snacks in recent five years which is fastest growing food sector because of their convenience. Consumer interest was raised in these food products due to their attractiveness, reasonable price, taste, appearance, texture, etc. <sup>[4]</sup>. Various technologies has been used extensively within the production of the RTE and RTC snacks products because of its easy operation methods where wouldn't used additional cooking and preparation, only focused on attractive packaging. Different types of food are come under RTE products such as sweet, salted, fried, canned food, Fast food, baked food, dried or preserved food, extruded food, etc. <sup>[3]</sup>. The traditional cereal consumption is dominated by various foods like bakery food, extruded food, instant snacks, fast food, breakfast cereals, biscuits and bars, etc. These food formulations are easy for human consumption and highly acceptable by customer because it shelf stable, lightweight, nutritionally enhanced, easy to shop and store.

Now a day's ready to eat/serve, ready to cook product are acquired large food market because it is closest replacement for our regular food. The young consumers are most like to spend their money for buying ready to eat and cook products. The demand is increased for these foods by young consumers which are easily targeted by RTE manufacturing companies due to convenience level, texture and pleasant taste during whole shelf life of products. Ready meal or snacks was capture consumer interest mainly due to its widely availability, convenience and snacking habit of consumer <sup>[9]</sup>. Therefore Indian as well as global consumer is steadily moves towards ready to eat and ready to cook food products instead of traditional cooking options. Different types of convenience food are made from cereals, pulses and millets including puffed and flake millets, pasta, noodles, baked products, extruded product, fermented food and

weaning food <sup>[5]</sup>. Bakery food, extruded food, fermented food, frozen food, weaning food is major types of food which referred as ready to eat meal or sometimes it need short cooking before consumption <sup>[15]</sup>. These types of foods are good for supplying instant energy and nutrient where its main purpose is partially satisfying hunger. It is easy for handling and transformation due its compact packaging and convenience size <sup>[6]</sup>. Ready to eat and cook foods are mostly make as snacks or in the form of frozen food such as fruits, vegetables, salad, processed meat, half boiled meat, processed fish, samosa, pizza, porotah, veg patty, shingara, etc. <sup>[46]</sup>.

## 2. Ready to eat (RTE) food product

Ready to eat food products are very acceptable and mostly popular food commodity for consumer due to their ease of preparation, storage, consumption. Various snacks products are come under RTE food including biscuit, breads, sandwiches, roll, soups, chips, fruits and vegetables salad, breakfast cereals, dairy products, etc. This list can become so long because new products entering under that category nearly every day. Fruits, vegetables and cereals are most important commodity for development of ready to eat food <sup>[1]</sup>. Where traditional food consumption is dominated by various readymade foods or meal like idlis, dosas, pav bhaji, mix fruit salads, veg curry, cereal biscuit and bar, chapatti, and meat products like precooked sausage, ham, chicken products and other instant food products <sup>[10]</sup>.

### 2.1 RTE Based on fruits and vegetables

Fruits and vegetables are plays important role to fulfill consumer nutritional requirement. It is rich source of dietary fiber, vitamins, minerals, polyphenols and other important bioactive compounds. Fresh fruits and vegetables are highly perishable due to high moisture content and water activity which is responsible for growth of microorganism <sup>[7]</sup>. Consumers are demanded fresh, healthy, easy to prepare and minimally processed fruits and vegetables. This demand was fulfilled by various instant food or ready to eat food making industries which are marketing these types of products due to its attractiveness, freshness and economical importance <sup>[3]</sup>.

Fruits and vegetables are referred as ready to eat food because it used for direct consumption or serve in the form of salad. The numbers of fruits and vegetables based RTE products are developed such as juice, jam, jelly, marmalades, canned products, prepared salad, vegetables curry, etc. Some fruits like strawberries, blueberries are mostly consumed because of its characteristic appearance and flavor; but it shows significant damages during harvesting, storage and transportation due to its perishable nature which causes loss of nutrients. Rico *et al.*, (2018) <sup>[8]</sup> are studies on mechanical properties and quality parameters of chitosan edible algae (palmaria palmata) on ready-to-eat strawberries. In this study they determine edible coating from CH-PC can reduces respiration rate, product loss as well as microbial load and improve nutrient value. Alvarez *et al.*, (2017) <sup>[3]</sup> studies on quality attributes of ready to eat blueberries regarding influence of dietary fiber added edible coating. They applied sodium alginate and chitosan edible coating with dietary fiber for evaluation of nutritional, microbiological and physicochemical properties of stored blueberries at 5 °C for 18 days. They found good result for CH coating where it significantly inhibit microbial growth, enhanced antioxidant properties and improved overall sensory and nutritional quality of blueberries. Patheeparambil (2020) <sup>[9]</sup> worked on

development of ready to eat fruit flakes which are formulated from cereal mix with addition of dried banana, papaya and apple flakes. The sensory quality of fruit flakes is moderately acceptable to consumer on the basis of various parameters. The microbial and nutritional qualities of product were analyst. This product is ready to consume after adding hot milk and sugar which preserved its traditional taste. Lucera *et al.*, (2017) <sup>[10]</sup> researched on to preserved product quality of semi-dried ready to eat tomato. They investigated that shelf-life of semi-dried tomato are improved by combine effect of antimicrobial compound and modified atmospheric pressure. Potassium sorbate is widely used food preservative in food industry as a strong antimicrobial activity to prevent product deterioration.

### 2.2 RTE Based on cereals and pulses

Cereals and pulses are important sector to make RTE food products. Cereals are mostly used in Indian daily diet in the form of 'roti'. The traditional cereal consumption is dominated by various food products like instant snacks, fast food, breakfast cereals, cereal biscuit and bar, etc. These food formulations are easy for human consumption and highly acceptable by customer because it minimizes the further cooking at home. The primarily cereals used are wheat, rice, corn, oats with some additives and fortifying agents which improve its shelf life, nutritional profile and overall quality <sup>[45]</sup>. Wheat and oats are majorly used for preparation of hot breakfast cereals where it required cooking before ready to consumption. Some variant of breakfast cereals are requires mixing of hot milk or water in bowl before consumption <sup>[11]</sup>. Extruded snacks, bakery products, nutria bars, cereals based chocolate bars, etc are major ready to eat food products prepared from cereals, legumes and pulses. It was capture consumer interest mainly due to its widely availability, convenience and snacking habit of consumer.

Omwamba and Mahungu (2014) <sup>[12]</sup> developed protein rich ready to eat extruded snack using composite blend of rice, sorghum and soybean flour. They define that extrusion is ideal cooking technique for development of RTE snacks which improves protein and starch digestibility in cereal snack products. The conclusion of their research is extrusion condition can produce product with increasing expansion ratio, low bulk density and improve nutritional quality to fulfill consumers need. Korkerd *et al.*, (2016) <sup>[13]</sup> worked on fortified extruded product made from food processing by product. In which defatted soybean meal, germinated brown rice meal, and mango peel fiber, were added to corn grit at 20% (w/w) to produce fortified extruded snacks. The rich source of protein and fiber from by product increases the nutritional quality and taste of product. Antioxidant activity and phenolic compounds are also enriched in it. Therefore it is successfully used as nutritional supplemented product. Borah *et al.*, (2016) <sup>[14]</sup> was optimized the process parameters for the extruded cooking of low-amylose rice flour, seeded banana (Musababisiana, ABB) and carambola (Averrhoa carambola L.) pomace. This product was development for making fiber and mineral rich breakfast cereal by using single screw extruded. They concluded that, pomace from carambola juice industry can be utilized for making mineral and functional ingredient rich product. Borah *et al.*, (2019) <sup>[15]</sup> studied role of food extrusion technology for development of healthy extruded products. The main motive of that study is to minimize the agricultural waste and utilize the naturally derived phytochemicals by using extruded process.

Sukumar *et al.*, (2018) <sup>[16]</sup> optimize the process parameter for extruded snacks which can be used as ready to eat food. They developed finger millets based extruded snacks fortified with banana powder using RSM. The combination of multi grains like rice flour, corn flour and cheese are fortified with banana powder and studied its properties. RSM was used for optimization of process parameters like barrel temperature, extruder rpm, banana powder concentration, etc. Central composite design with three levels, three factors are used and analyzed for study of various physical parameters of product. The changes in process parameters significantly affect on physical properties RTE extruded snacks. It plays an important role in development of high quality extruded product. Yaman *et al.*, (2019) <sup>[17]</sup> studies on various parameters of ready to eat meal consumed in Turkey. They produced ready to eat breakfast cereals products by using extrusion technology and examined free sugar content, *in vitro* starch digestibility and predicted glycemic index. They obtained results, where GIs of sample were lower than other samples containing 12 breakfast cereals containing rice and corn. It is sugar free extruded sample when it was formulated with oats. Iqbal *et al.*, (2021) <sup>[45]</sup> studies on utilization of buckwheat and bread waste for development of nutritious ready to eat snacks which give protein, fibers, and minerals and it reduces fat. It is healthy snacks made from bakery waste and buckwheat. Ready to eat cereals, milk and fruit intake is good in breakfast as a part of healthy diet. Michels *et al.*, (2016) <sup>[18]</sup> analyzed dietary characteristics of breakfast cereals in European adolescents due to its popularity among all the breakfast options. Milk and fruit intake at breakfast gives higher glucose and fructose which is better for consumer than bread and other breakfast. They concluded Ready to eat cereals; milk and fruits are better breakfast options for a balanced diet. Momanyi *et al.*, (2020) <sup>[19]</sup> work on formulation, nutritional and sensory evaluation of baobab based ready to eat sorghum cowpea blend snack bars. In Kenya, sorghum, cowpea and baobab are mostly grown drought tolerance crops which are used for development of ready to eat snack bars. They analyzed physical, nutritional and sensory attributes of snack bar in five different formulations. They concluded from research that this cereal based snack bar can be served as a diversified diet to increase nutrient intake from homemade snack.

### 2.3 RTE Based on meat, fish and poultry

Meat, poultry and fish based ready to eat food products are also widely acceptable food commodities in the food market. Due to increasing demand and globalization, the food safety and quality concern is also increased towards perishable food like meat and fish. These products are very sensitive to microbial growth and fungal contamination causing undesirable changes in flavor, odor, sensory and color as well as lipid oxidation is a major deterioration of quality during processing and storage of product <sup>[20]</sup>. The convenience of meat and poultry products is mostly generated through various processing technologies available for minimal preparation at household level. The wide availability, eating pattern and food related lifestyle is majorly responsible for increasing popularity of meat and fish based snack products. Processed ready to eat meat are high in chemical preservative, salt and fat content which caused unhealthy life and diseases like risk of cancer and coronary conditions <sup>[21]</sup>.

Liu *et al.*, (2020) <sup>[22]</sup> shows the native effect of nanoemulsion based active coating (NEAC) with a mixture of natural antimicrobial as a novel alternative and checked quality and shelf

life of ready to eat yao meat products. This study was conducted for preparation and evaluation of nanoemulsion based active coating on quality attributes of yao meat. Its result suggested that application of NEAC and natural antimicrobial agent shows good retention of color, odor, flavor, overall quality and shelf life of ready to eat yao meat products. Fruit antioxidants are also applicable on meat or chicken products. Devatkal, Narsan and Borah (2010) <sup>[23]</sup> had studied that the effect of salt, kinnow extract and pomegranate fruit on oxidative stability and color of raw chicken patties during refrigerated storage. The effect of antioxidant from the fruit extract on meat product is evaluated on the basis of storage stability during refrigeration. Various treatments are applied for checking results of reducing auto-oxidation and salt promoted oxidation in chicken patties during storage. Kuna *et al.*, (2013) <sup>[24]</sup> utilize fish powder in ready to eat extruded snacks which were developed using corn, rice, roasted Bengal gram dal, green gram, black gram and fish powder. This product was undergone storage acceptability studies for two months at laboratory scale using 5 point hedonic scale. The result shows that extruded product from fish powder is good quality and more acceptable ready to eat snacks.

### 3. Ready to cook (RTC) food products

Ready to cook products are the type of food which are processed or prepared with very little extra effort and it is also called as convenience food. Urbanization and globalization change people's lifestyle and living standards. RTC consumers are mostly from urban areas including bachelors and busy life people in cities <sup>[25]</sup>. Demand for ready to cook food is increasing because number of factors are responsible for it such as ready availability of food, culturally acceptable, nutritive and minimally processed, urbanization of domestic labor, dearth of time, convenience of food, increase in per capita income, and affordable by middle class people. Ready to cook meal can be considered as the best alternative for homemade meal and its consumption trends are increasing due to increasing working women populations <sup>[26]</sup>.

#### 3.1 RTC Based on fruits and vegetables

Fruits and vegetables are rich sources of dietary fiber, vitamins, minerals, polyphenols and other important bioactive compounds. It plays an important role to fulfill consumer nutritional requirements. Vegetables are highly perishable due to high moisture content and water activity which is responsible for growth of microorganisms. Consumers demand fresh, healthy, easy to prepare and minimally processed fruits and vegetables <sup>[1]</sup>. These entire factors affect on food supply chain in the food market which increases demand for dehydrated ready to cook vegetables in developing and developed countries. Dehydrated and blanched fruits and vegetables are healthy snacking options for health conscious people due to their minimal processing and low added preservatives <sup>[27]</sup>.

Liji *et al.*, (2015) <sup>[28]</sup>, developed jackfruit based ready to cook instant 'avail' mix where its main objective was to develop value added product from raw jackfruit and its quality analysis. 'Avail' is a popular jackfruit based Kerala dish and its important processing method was standardization on the basis of various parameters. This mix contains jackfruit bulb and seed, turmeric powder, cumin, green chili, garlic and curry leaves. They found this product was convenient and acceptable and also popular among the urban classes. Malik and Kajla (2020) <sup>[25]</sup> conduct a research on determine



nutritional and microbiological quality of ready to cook mixed vegetable curry. The various pretreatment such as washing, cutting, boiling, blanching and drying was applied on seasonal a vegetable which includes cauliflower, pea, carrot, potato, beans, etc. onion, garlic, spices and herb gravy mix powder was used for flavor and the curry was made. Where they were concluded that dried and blanched vegetables shows longer shelf life and retained many nutrients and also ready to cook curry is quick and healthy option. Lwin *et al.*, (2020) <sup>[29]</sup> investigates the effect of ultraviolet-C irradiation to maintain total sugar concentration and texture of RTC baby corn during commercial cold storage. UV-C were irradiate to baby corn at different doses of 0, 2.2, 4.4, 6.6 kJ m<sup>-2</sup> and stored which shows result of losses of total sugar and prevent electronic losses at 4.4 kJ m<sup>-2</sup>. Therefore they concluded that 4.4 kJ m<sup>-2</sup> is best alternative for UV-C treatment which maintain total sugar concentration and texture of ready to cook baby corn. Bandara *et al.*, (2018) <sup>[30]</sup> developed ready to cook vegetables mixture which is important for preserve its nutritional content. Carrot, cabbage, eggplant, green bean, pumpkin are five vegetables used for making vegetable mix. Different microbial study such as total plate count test, yeast and mold test, coliform test was safe. Physicochemical and sensory evaluation is also acceptable by consumer.

### 3.2 RTC Based on cereals and pulses

Cereals are majorly used supplement for preparation of ready to cook food products. Rice, wheat, oats, sorghum, corn are majorly used cereals for development of ready to cook product. Pasta, noodles, snacks product, weaning food, breakfast cereals, modified starch, pet food, etc. are the example of cereal based products. The old traditional technique of cereal cooking is puffing or popping which used for making snacks and breakfast cereals. Pasta, noodle and papad are other form of ready to cook products from flour of cereal and legumes where cold extrusion method is used. Bakery products are also popular snacks due to its low cost, varied taste, texture, attractive packaging and longer shelf life <sup>[5]</sup>.

Sathiyabamavathy and Sekhar (2020) <sup>[26]</sup> conduct a survey on consumer preference for ready to cook food products based on rice. Where they realize that consumers in India are spend around half of their income and in world, one third of their income are spend on food. In this study they highlight the increasing demand for ready to cook food products and they concluded that this study can be used for redesigning and marketing of ready meals or products. Arora *et al.*, (2018) <sup>[31]</sup> are evaluating the nutritional and quality characteristics of instant noodle supplements with oyster mushroom (*P. ostreatus*). Addition of mushroom powder (2-10%) as protein supplement in ready to cook instant noodles was evaluated the effects on texture, nutritional and sensory quality of product. Only after addition of 4% mushroom powder, it shows significant increase in cooking time, water absorption and tensile strength. They were successfully optimizing the product with high protein content (11.32) and fiber content (1.96) where it was respectively 17.3% and 8.89% more than control sample. Jaybhay *et al.*, (2014) <sup>[5]</sup> make review on processing and technology of nutritionally rich millet based food products. Millets are nutritionally superior to cereal and plays important role in peoples diet in various region of world. Different types of convenience food are made from millets including puffed and flake millets, pasta, noodles, baked products, extruded product, fermented food and

weaning food.

Rao *et al.*, (2018) <sup>[32]</sup> are studies on ready to cook extruded sorghum pasta fortified with gingelly seeds. In this study value added product was made from sorghum as vehicle for fortification with zinc where gingelly seed are used as natural fortificant for zinc. Physic-chemical properties of 20% gingelly fortified sorghum pasta is showing higher protein, fat, ash, carbohydrate content. Shelf life of developed product was three month without any deterioration. They concluded that, gingelly fortified sorghum pasta are enhance the zinc content in ready to eat product. Takhellambam *et al.*, (2015) <sup>[33]</sup> studies on demand of modern consumer for ready to eat millets flask based on minor millets. Various convenient foods based on minor millets such as little, proso, barnyard and Ragi are processed for meet the need of modern consumer. The physical and chemical properties are checked for different minor millets and they concluded that among the millets, little millet flask was more acceptable in terms of sensory and microbial quality. The shelf life of product was nearby four month at ambient temperature.

Mung dal nuggets were developed by Pardeshi *et al.*, (2013) <sup>[34]</sup> by cold extrusion method. Wheat flour and mix mung flour is used to prepare nuggets in pasta machine by cold extrusion technique. RMS is used for result analysis where dried extruded pasta having better chewing feeling after proper cooking. They said that, developed nugget gets less cooking as well as processing cost than traditional mung nuggets. The shelf life is nearby 114 days at 30<sup>0C</sup> when packed in metalized polyester. Dalbhagat *et al.*, (2019) <sup>[35]</sup> make a review on effect of extrusion processing on physicochemical, function and nutritional characteristic of various rice based food products. Rice (*oryza sativa* L.) is important cereals crop which is used in various ready to cook products like snacks product, pasta, noodles, weaning food, breakfast cereals, modified starch, pet food, etc. Extrusion technique makes product with better nutritional, sensory and functional quality. In this review they highlight the use of extrusion technology for development of various rice and rice based products. Benhur *et al.*, (2015) <sup>[36]</sup> develop and standardize the sorghum pasta using extrusion cooking where pasta from sorghum is not practiced in India. Therefore they mixed sorghum cultivator M 35-1 with wheat semolina to make standardize pasta. Physicochemical, nutritional and sensory quality was evaluated and developed sorghum pasta.

### 3.3 RTC Based on meat, fish and poultry

Meat and fish are better source of various nutritive and bioactive compounds such as vitamin, calcium, chain n-3 fatty acid and minerals like copper, iron, zinc, iodine, manganese, selenium, etc. It is also excellence source of protein and amino acids. Snacks are important for providing instant nutrition from food where demand for meat snack is increasing due to its taste, texture, flavor and nutritional composition. Different cooking technologies were used for development of ready to cook meat and fish products such a extrusion, enrobing, coating, etc. The several types of meat and fish products are popular in worldwide, however major snacks are jerky, popped pork rind, pepperettes, meat biscuit, meat cookies, meat chips, meat noodles, meat momos, fish cutlets, etc. Extrusion is widely used processing technology for development of ready to cook fish and meat products. It's gaining huge importance due to their unique taste, texture, convenience and overall acceptability <sup>[37]</sup>.

Ready to cook fish products are getting to popular in food

market due to changing lifestyle of peoples. Nayma *et al.*, (2020) <sup>[38]</sup> are studies on ready to eat pangas fish (*Pangasianodon hypophthalmus*) curry with modified atmosphere packaging. MAP is widely used technique for packaging of chilled fish and its products it was used to extend shelf life of product. In this study they analyze the biochemical and microbiological analysis. 75%CO<sub>2</sub> and 25% N<sub>2</sub> pack of modified atmospheric packaging is considered as acceptable limit for frozen fish and fish products. It also can used in superstore to show type of food with extending its shelf life. Meat and poultry are source of many nutrients but its preservation is major challenge in front of processing units. Zhang *et al.*, (2018) <sup>[39]</sup> investigate the antimicrobial and antioxidant effect of edible coating on chitosan and bamboo vinegar in RTC pork chops. CH-BV solution is affect on quality and shelf life of pork chops where it treats tended to retard lipid oxidation by minimizing TBARS value. They concluded that, edible coating on ready to eat meat products are important for improve shelf life and food safety. Ready to eat barbeque chicken was developed by khaledian *et al.*, (2019) <sup>[40]</sup> from cellulose nanofibers coating incorporated with ginger essential oil and citric acid. This study was held to access the impact of cellulose nanofibers coating for shelf life extension of barbeque chicken meat. Ginger essential oil and citric acid are act as antimicrobial compound which have better impact on spoilage control. The result of this study shows importance of food coating for increasing shelf life and incorporating antioxidant and antimicrobial compounds in meat products. Surasani (2016) <sup>[37]</sup> is developed fish meat based extruded product which provides great versatility for formulation of highly nutritive, convenient and low cost food product. Extruded products contain low level protein therefore they are fortified with protein rich food like meat, fish and poultry. There is increasing demand for fish based products in extrusion process for promoting their utilization. It is also important for value addition, low cost food and development of convenience food products. Pandi *et al.*, (2019) <sup>[41]</sup> evaluate nutritional and organoleptic characteristics of extruded fish snacks. When fish protein is incorporated with snacks then it improves the nutritional profile of product. In this study dried fish powder was mixed in snacks and evaluates nutritional and organoleptic quality of product. Finally they concluded that developed product was nutritionally rich and more acceptable by consumer. Shahmohammadi *et al.*, (2014) <sup>[42]</sup> developed puffed corn fish snacks by using extrusion technology where they used different blends of corn grits and silver carp minced meat. They studied the fish meat content for optimum formulation which is obtained at 15% of minced fish.

**4. Retort processing and packaging of RTE/RTC food products:** Snacks or instant food like ready to eat and ready to cook products are a group of food which are convenient, small in size, satisfy to people, household, children, short time hunger, working women and carry at time of travelling. These foods are good for supplying energy and nutrient and its main purpose is partially satisfying hunger. It is easy for handling and transformation due its compact packaging and convenience size <sup>[6]</sup>. Demand for ready to eat and cook foods are increasing due to various changes in socio-economic and culture pattern of people.

Packaging of snacks products is important to increase shelf life of food and also it controls weight loss and reduces transportation cost. To preserve texture attributes, moisture

content, grease and air proofs of product, laminated packaging material is mostly used. Consumers are preferred ready to eat products because of its advantageous less time and effort. Packaging is used to show nutritional content, quality of meal, shelf life and marketing of product <sup>[43]</sup>. Shelf life studies of ready to cook product was conducted by <sup>[44]</sup>. They developed nutrient rich and convenient packed product using bio diversified millet. Packaging and shelf life study was done for ready to eat khichdi which indicates product had good shelf life at ambient temperature or condition. This product is natural and nutritious without using additives or preservatives.

## 5. Health impact and Microbial safety of RTE and RTC products

Ready to eat or ready to cook food are also referred as fast food which are easy to make and consume. It commonly includes frozen dinner, packed snack food, bread, pasta, breakfast cereals, fruit snacks, sauces, processed meat, protein bars, etc. These food products are processed or ultra processed which improves its quality or sometimes decreases nutritional quality and microbial quality <sup>[38]</sup>. These types of food are healthy, convenient and accessible but excess intake can be harmful to our health.

Some fast foods contains high amount of fat, salt, sugar and other chemicals. The excessive intake causes adverse effect on health such as overweight, heart related problems and other undesirable health conditions <sup>[46]</sup>. The junk foods like pizza, burger, sandwich, and seared chicken are made from excessive fat material like cheese, vegetable oil, etc which increases bodyweight. Excessive salt and sugar containing foods such as bread, chips, Kurkure, biscuits, cakes, lollipop, etc. which make it tastier. But these types of food are doing bad effect on health after excessive intake.

Fresh products from fruits, vegetables, cereals, meat, fish are highly perishable due to its high moisture content and water activity which responsible for growth of microorganism <sup>[1]</sup>. Physicochemical quality and microbial safety of fresh cut watermelon and pineapple was evaluated by Piano and Castillo-Israel (2019) <sup>[47]</sup>. In this study they select top selling area of these products and compare wet market sample with supermarket sample. Vitamin C content is lower in fresh cut sample than whole fruit and pineapple samples are positive for microbial growth of *salmonella* species. Berthold-Pluta *et al.*, (2017) <sup>[48]</sup> are determining microbial quality of plant origin ready to eat (RTE) food products. Sixty RTE samples were analyzed including per twenty samples of vegetables, sprouts and non-pasteurized fruit and vegetable juice respectively. This study show presence of *cronobacter* spp. in around 21 samples and the highest microbial contamination was detected in samples of sprouts. Garibaldi *et al.*, (2019) <sup>[50]</sup> evaluate the quality of ready to eat swordfish inoculated with probiotic strain *lactobacillus paracasei* for 3 month at 4°C temperature. In this study they examine the microbiological test, fatty acid profile, malondialdehyde content. Result shows growth of probiotic strains and difference in lipid profile and lipid oxidation. Therefore they concludes that probiotic strain delay the lipid oxidation and increases the retention of polyunsaturated fatty acid. Fruits and vegetables provide higher nutrition when they are fresh state. Fresh cut fruits and vegetables are increases respiratory rate and ethylene production which causes microbial spoilage. Raw consumption of fruits and vegetables are potential to health hazards which said by Wan *et al.*, (2020) <sup>[49]</sup>. Where they are developed one examination kit from SLB (selective Luria

bertani broth) with a loop-mediated isothermal amplification (LAMP) kit for detection of salmonella in ready to eat foods. They concluded that this technique improve result accuracy. Sant Anna *et al.*, (2020) <sup>[51]</sup> bring an overview on microbial safety of minimally processed vegetables. They said that ready to eat minimally processed vegetables are needs to maintain nutritional and sensory attributes for reduce microbial load, inactive pathogens and prevent cross contamination. They increased awareness in consumer, industry and government regarding food borne illness associated from consumption of RTE-MPV. Therefore the proper sanitization and safety during production of Ready to eat products is mandatory for giving good quality product to consumer.

## 6. Conclusion

Modern peoples are changed their lifestyle and behavior towards ready to eat and ready to cook products where number of fast food are available in market. They are response to the products which are fresh and easy to prepare. In this review we studied that ready to eat food is category of food which comprised packed food products used to direct consumption where ready to cook food are prepared with very little extra efforts. Fruits, vegetables, cereals, pulses, meat, fish are major category of food which used for making ready to eat and ready to cook. The number of innovations and various technologies are applied to make nutritious and good quality ready meals. These types of food are healthy, convenient and accessible but excess intake can be harmful to our health. Microbial safety is also important factor which determines quality, shelf life of product and human health effects.

## 7. References

1. Malik T, Saxena M, Sonu KS. Development of a ready to cook curry. *Int J Innov Sci Res Technol* 2018;3(3):354-357.
2. Research and market India Ready-To-Eat Food (RTE) Market Study, 2013-2023: Analysis by Segment, Distribution Channel and State, Featuring Profiles of Leading Players 2020.
3. Alvarez MV, Ponce AG, Moreira MR. Influence of polysaccharide- based edible coatings as carriers of prebiotic fibers on quality attributes of ready- to- eat fresh blueberries. *Journal of the Science of Food and Agriculture* 2018;98(7):2587-2597.
4. Patel D, Rathod R. Ready-to-eat food perception, food preferences and food choice—a theoretical discussion. *Worldwide Journal of Multidisciplinary Research and Development*. 2017;3(8):198-205.
5. Jaybhaye RV, Pardeshi IL, Vengaiyah PC, Srivastav PP. Processing and technology for millet based food products: a review. *Journal of ready to eat food*, 2014;1(2):32-48.
6. Kumar P, Verma AK, Kumar D, Umaraw P, Mehta N, Malav OP. Meat Snacks: A novel technological perspective. In *Innovations in Traditional Foods* Woodhead Publishing 2019, 293-321.
7. Malik T, Kajla P. Development of ready to cook curry from dried vegetables. *Int. J. Chem. Stud* 2018;SP4:136-140.
8. Rico D, Barcenilla B, Meabe A, González C, Martín-Diana AB. Mechanical properties and quality parameters of chitosan- edible algae (*Palmaria palmata*) on ready-to- eat strawberries. *Journal of the Science of Food and Agriculture* 2019;99(6):2910-2921.
9. Patheeparambil AP. Development Of Ready To Eat Fruit Flakes. *Food and Agriculture Spectrum Journal* 2020;1(4).
10. Lucera A, Conte A, Gammariello D, Del Nobile MA. Ready- to- eat semi- dried tomatoes: Study to preserve the product quality. *Journal of Food Processing and Preservation*, 2017;41(5):e13175.
11. Espinoza-Moreno RJ, Reyes-Moreno C, Milán-Carrillo J, López-Valenzuela JA, Paredes-López O, Gutiérrez-Dorado R. Healthy ready-to-eat expanded snack with high nutritional and antioxidant value produced from whole amarantin transgenic maize and black common bean. *Plant Foods for Human Nutrition* 2016;71(2):218-224.
12. Omwamba M, Mahungu SM. Development of a protein-rich ready-to-eat extruded snack from a composite blend of rice, sorghum and soybean flour. *Food and Nutrition Sciences* 2014.
13. Korkerd S, Wanlapa S, Puttanlek C, Uttapap D, Rungsardthong V. Expansion and functional properties of extruded snacks enriched with nutrition sources from food processing by-products. *Journal of food science and technology* 2016;53(1):561-570.
14. Borah A, Mahanta CL, Kalita D. Optimization of process parameters for extrusion cooking of low amylose rice flour blended with seeded banana and carambola pomace for development of minerals and fiber rich breakfast cereal. *Journal of food science and technology* 2016;53(1):221-232.
15. Borah, Anjan, Chutia, Hemanta, Balasubramanian S, Mahanta, Charu. Role of Food Extrusion in Development of Healthy Food Products: A Review in "AS Nutrition Health". 2019;(4):39-44. 10.31080/ASNH.2019.S01.0010.
16. Sukumar A, Athmaselvi KA. Optimization of process parameters for the development of finger millet based multigrain extruded snack food fortified with banana powder using RSM. *Journal of food science and technology* 2019;56(2):705-712.
17. Yaman M, Sargin HS, Mızrak ÖF. Free sugar content, in vitro starch digestibility and predicted glycemic index of ready-to-eat breakfast cereals commonly consumed in Turkey: An evaluation of nutritional quality. *International journal of biological macromolecules* 2019;135:1082-1087.
18. Michels N, De Henauw S, Beghin L, Cuenca-García M, Gonzalez-Gross M, Hallstrom L *et al.* Ready-to-eat cereals improve nutrient, milk and fruit intake at breakfast in European adolescents. *European journal of nutrition* 2016;55(2):771-779.
19. Momanyi D, Owino W, Makokha A. Formulation, nutritional and sensory evaluation of baobab based ready-to-eat sorghum and cowpea blend snack bars. *Scientific African* 2020;7:e00215.
20. Nikmaram N, Budaraju S, Barba FJ, Lorenzo JM, Cox RB, Mallikarjunan K *et al.* Application of plant extracts to improve the shelf-life, nutritional and health-related properties of ready-to-eat meat products. *Meat science* 2018;145:245-255.
21. De Barcellos MD, Grunert KG, Scholderer J. Processed meat products: consumer trends and emerging markets. In *Processed Meats* Woodhead Publishing 2011, 30-53.
22. Liu Q, Zhang M, Bhandari B, Xu J, Yang C. Effects of nanoemulsion-based active coatings with composite mixture of star anise essential oil, polylysine, and nisin on the quality and shelf life of ready-to-eat Yao meat



- products. *Food Control* 2020;107:106771.
23. Devatkal SK, Naveena BM. Effect of salt, kinnow and pomegranate fruit by-product powders on color and oxidative stability of raw ground goat meat during refrigerated storage. *Meat science* 2010;85(2):306-311.
  24. Kuna A, Devi NL, Kalpana K. Utilization of fish powder in ready-to-eat extruded snacks. *Fishery Technology* 2013;50(3).
  25. Malik T, Kajla P. Comparative nutritional and microbiological quality of ready to cook mixed vegetable curry. *Journal of Food Science and Technology* 2020, 1-8.
  26. Sathiyabamavathy K, Sekhar C. Consumer Preference for Rice-based Ready to Cook Food Products in Coimbatore City. *Mukt Shabd Journal* 2020;9:2055-2064.
  27. Deng LZ, Mujumdar AS, Zhang Q, Yang XH, Wang J, Zheng ZA *et al.* Chemical and physical pretreatments of fruits and vegetables: Effects on drying characteristics and quality attributes—a comprehensive review. *Critical reviews in food science and nutrition* 2019;59(9):1408-1432.
  28. Liji AJ, Divakar S, Ukkuru M, Nandini PV, Mini C. Development of jack fruit based ready-to-cook (RTC) instant “avail” Mix 2015.
  29. Ngu Lwin NT, Supapvanich S, Promyou S. Ultraviolet-C irradiation maintaining texture and total sugars content of ready to cook baby corn during commercial storage. *Food science and biotechnology* 2021;30(1):47-54.
  30. Bandara DA, Sarananda KH, Mahendran T, Hariharan G. Processing and Quality Evaluation of Ready-to-Cook (RTC) Dehydrated Vegetables Mixture. *Processing and Quality Evaluation of Ready-to-Cook (RTC) Dehydrated Vegetables Mixture* 2018;3(1):13-13.
  31. Arora B, Kamal S, Sharma VP. Nutritional and quality characteristics of instant noodles supplemented with oyster mushroom (*P. ostreatus*). *Journal of food processing and preservation* 2018;42(2):e13521.
  32. Rao BD, Kiranmai E, Hariprasanna K, Tonapi VA. Studies on ready to cook gingelly fortified extruded food-sorghum pasta. *Int J Chem Stud* 2018;6:2460-2464.
  33. Takhellambam RD, Chimmad BV, Prkasam JN. Ready-to-cook millet flakes based on minor millets for modern consumer. *Journal of food science and technology* 2016;53(2):1312-1318.
  34. Pardeshi IL, Bhuskade SA, Kalmegh VB. Development of cold extruded ready-to-cook Mung (*Vigna radiata* L.) nuggets. *Journal of Food Research and Technology* 2013;1(1):21-28.
  35. Dalbhat CG, Mahato DK, Mishra HN. Effect of extrusion processing on physicochemical, functional and nutritional characteristics of rice and rice-based products: A review. *Trends in food science & technology* 2019;85:226-240.
  36. Benhur DR, Bhargavi G, Kalpana K, Vishala AD, Ganapathy KN, Patil JV. Development and standardization of sorghum pasta using extrusion technology. *Journal of Food Science and technology* 2015;52(10):6828-6833.
  37. Surasani VKR. Application of food extrusion process to develop fish meat-based extruded products. *Food engineering reviews*, 2016;8(4):448-456.
  38. Nayma K, Das KC, Alice EJ, Mehbub MF, Islam MT. Extension of shelf-life of ready-to-cook (RTC) pangas fish (*Pangasianodon hypophthalmus*) curry by modified atmosphere packaging at chilled storage. In *IOP Conference Series: Earth and Environmental Science*. IOP Publishing. 2020;414(1):012015
  39. Zhang H, He P, Kang H, Li X. Antioxidant and antimicrobial effects of edible coating based on chitosan and bamboo vinegar in ready to cook pork chops. *Lwt*, 2018;93:470-476.
  40. Khaledian, Yousef, Pajohi Alamoti, Mohammadreza, Bazargani-Gilani, Behnaz. Development of cellulose nanofibers coating incorporated with ginger essential oil and citric acid to extend the shelf life of ready- to- cook barbecue chicken. *Journal of Food Processing and Preservation* 2019, 43. 10.1111/jfpp.14114.
  41. Pandi G, Rathnakumar K, Velayutham P, Shakila RJ, Anand S, Arone BN. Extruded Fish Snack from Low Valued Fatty Fish: An Evaluation of Nutritional and Organoleptic Characteristics. *Journal of Coastal Research* 2019;86(SI):61-64.
  42. Shahmohammadi HR, Bakar, Jamilah, Abdul Rahman, Russly, Mohd Adzahan, Noranizan *et al.* Puffed corn-fish snack development by extrusion technology. *Iranian Journal of Fisheries Sciences* 2014;13:748-760.
  43. Silberbauer A, Schmid M. Packaging concepts for ready-to-eat food: recent progress. *Journal of Packaging Technology and Research* 2017;1(3):113-126.
  44. Chhabra I, Kaur A. Development of a convenient, nutritious ready to cook packaged product using millets with a batch scale process development for a small-scale enterprise. *Journal of Food Science and Technology*, 2021, 1-10.
  45. Iqbal S, Thanushree MP, Sudha ML, Crassina K. Quality characteristics of buckwheat (*Fagopyrum esculentum*) based nutritious ready-to-eat extruded baked snack. *Journal of Food Science and Technology* 2021;58(5):2034-2040.
  46. Hassan SA, Bhateja S, Arora G, Prathyusha F. Impact of junk food on health. *Journal of Management Research and Analysis* 2020;7(2):57-59.
  47. Piano AMP, Israel, Katherine Ann. Physico-chemical quality and microbial safety evaluation of ready-to-eat freshcut watermelon and pineapple sold in Imus, Cavite, Philippines. *Food Research* 2019;684-692. 10.26656/fr.2017;3(6):139.
  48. Berthold-Pluta, Anna, Garbowska, Monika, Stefańska, Ilona, *et al.* Microbiological quality of selected ready-to-eat leaf vegetables, sprouts and non-pasteurized fresh fruit-vegetable juices including the presence of *Cronobacter* spp. *Food Microbiology*. 2017;65:221-230.
  49. Wan J, Lu Z, Bie X, Lv F, Zhao H. Improvement of a new selective enrichment broth for culturing *Salmonella* in ready- to- eat fruits and vegetables. *Journal of Food Safety* 2020;40(5):e12817.
  50. Giribaldi, Marzia, Gai, Francesco, Peiretti, Pier Giorgio *et al.* Quality of ready-to-eat swordfish fillets inoculated by *Lactobacillus paracasei* IMPC 2.1: Quality of probiotic ready-to-eat swordfish fillets. *Journal of the Science of Food and Agriculture*. 2018;99: 10.1002/jsfa.9161.
  51. Sant'Anna, Pedro, Franco, Bernadette, Maffei, Daniele. Microbiological safety of ready- to- eat minimally processed vegetables in Brazil: an overview. *Journal of the Science of Food and Agriculture* 2020, 100. 10.1002/jsfa.10438