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Development of retort process for ready-to-eat (RTE) soy-peas curry as a meat alternative in multilayer flexible retort pouches

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Abstract

Effect of retort processing on the shelf life and safety of ethnic Indian food product namely soya peas curry was investigated. Ready-to-eat soya peas curry was packed in laminated retort pouches and processed in a steam-air retort with overriding pressure. Time-temperature profile of processing was determined and the same was used for heat penetration characteristics. The thermal processing parameters like retort temperature, heating lag factor (J_h), heating rate index (f_h), process time (B), F_0 value and Cook value (C_g) were determined. The retort processed soya peas curry was analysed for microbiological, sensory and chemical characteristics under refrigerated (4-5°C), ambient (27-30°C) and accelerated temperature (45°C) for a period of 9 months. Microbiological analysis indicated that retort processing achieved commercial sterility. The changes in chemical characteristics and sensory quality on storage were insignificant. The samples were rated excellent by the taste panel and remained in good condition even after 9 months of storage.

Introduction

There is a growing consumer interest in related eating patterns such as the avoidance or reduced consumption of red meat. An estimated 7 million people currently either avoid red meat or are vegetarians, compared with 2 million in 1984 (Realeat, 2001). The continuing consumer interest in vegetarianism and more generally in the choice of occasional meat-free meals as part of a varied diet, are the key driving forces behind consumer demand for high quality and convenient meat alternative products. Industry has responded to this demand with technological developments that have enabled the use of an increasing range of main ingredients in the manufacture of meat alternative products. Meat alternative ingredients are nutritious with some offering specific health benefits. As well as increasing consumer choice, such products therefore have the potential to contribute to overall public health. The Realeat survey, conducted by Gallup, also highlights consumer perceptions that meat-free alternatives offer positive health benefits (Realeat, 2001). Looking back 20–30 years ago ‘vegetarian’ convenience foods were few and far between and were mainly based on textured soya protein or nuts. Though soya has been a dietary staple in China for over 4000 years, it is only over the past 40 years that soya products have become more widely consumed in the West. The main forms, in which soya is used in meat alternative products include soya protein isolate, textured soya protein and tofu. Textured soya protein is made from defatted soya flour, from which soluble carbohydrates have been removed and the residue is textured by spinning or by extrusion. It is then dehydrated which gives a sponge like texture. It can be flavoured to resemble meat and can be presented as chunks or granules. Textured soya protein is used in products such as vegetarian burgers, meat-free sausages and other meat-free convenience foods. It is also sold as an ingredient for home cooking e.g. soya mince and chunks (Sadler, 2004).

There is an increasing consumer demand for high quality convenient ready-to-eat food products and has led to an increase in the commercial production of ready-to-eat products (Kumar *et al*., 2013). Retort pouch processing technology has been widely recognized as one of the alternatives to metal cans for producing thermally processed shelf stable foods (Sabapathy *et al*., 2001). The retortable pouch is a flexible laminated pouch that can withstand thermal processing temperatures and combine the advantages of the metal can and plastic packages. Flexible retortable pouches are unique alternative packaging method for sterile, shelf stable products (Sabapathy and Bawa, 2003). The retort pouches have many advantages over canned and frozen food packages, both for the customers as well as food manufacturers. The advantages are pouch profile, package cost,

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storage and preparation efficiency, savings in transportation, improved flavour and energy saving (Kumar *et al*., 2007). Therefore, in this study an attempt has been made to develop shelf-stable ready-to-eat soya-peas curry as an alternate for meat products using retort pouch processing technique as well as to evaluate the changes in quality attributes during storage.

Materials and Methods

Products preparation

The ingredients used for the preparations of Soy-peas curry was given in Table 1. High quality soya chunks (texturized soya protein) and dried green peas were procured from the local market to make soya peas curry. Green peas was soaked overnight to rehydrate and soaking of soya chunks has been done for 4 hours followed by blanching and subsequent washings (along with squeezing) were given for several times to remove traces of beany off - odour if any. Cooking of traditional curry ingredients (i.e. ginger, garlic, onion, tomato and masala) was done in steam heated open type kettles. This moderately cooked curry was then packed in retort pouches along with blanched soya chunks and green peas followed by retort pouch processing to attain commercial sterility (Figure 1).

Retort pouch processing of RTE soya peas curry

Retort pouch processing of soya peas curry was carried out in a steam-air retort, following the method given by Kumar *et al.* (2013). The retort was equipped with facility of using compressed air for over-riding pressure and a high-pressure water-circulating pump for pressurized cooling. The temperature of the product was recorded continuously during heat processing, through copper-constantan thermo couples, which were fixed at the geometric centres of the pouches. The pouches were kept at different positions inside the retort. The internal temperature of the pouch and temperature of retort was calculated from the thermo-electro-motive-force at regular intervals of 1 min. The F_0 value was calculated from the time - temperature history. The pouches were initially heated till there inside temperature reached 100ºC. The pressure of the steam was raised subsequently in stages; from 5 lbs to 15 lbs. gauge pressure with the increase of temperature progressively. The processing was carried out to achieve required F_0 value with maximum temperature of 121.1ºC. After attaining the required F_0 value, the product temperature was brought down to 50-55ºC with the help of pressurized cooling (compressed air and water) in 4-5 minutes.

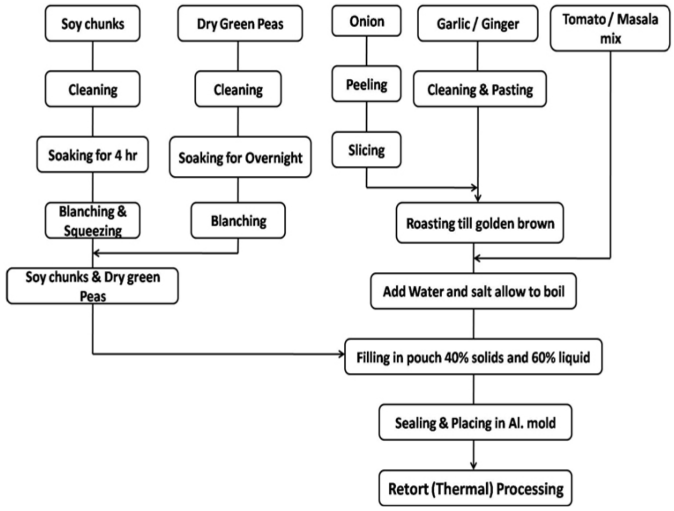

Figure 1. Flow chart for preparation and retort processing of soya peas curry

The cooled pouches were wiped dry and examined for visual defects if any.

Proximate and chemical analysis of the sample

Proximate analysis of the samples was done according to AOAC (1990). Percentage of Free Fatty acid (FFA) expressed as oleic acid and Peroxide Value (PV) were estimated according to the method of Ranganna (2000).

Microbiological analysis

The soya peas curry was analysed for its commercial sterility. The pouches were incubated at 37ºC and 55ºC for 7 days. SPC was determined using dextrose tryptone agar (DTA) after incubation for 48 h at 30ºC. Yeast and mould count was estimated with the help of acidified potato dextrose agar (PDA), after incubation at 30ºC for 4-5 days. Spore formers were determined after killing the vegetative cells by keeping the sample in boiling water bath for 10 to 20 minutes and subsequently incubated at 37ºC and 55ºC for 48 h after incubation (Harrigan and Mc Cance, 1976).

Storage analysis

Soya peas curry was stored under different temperatures, i.e refrigerated storage (4-5°C), ambient temperature (27-30°C), and elevated temperature (45°C). The samples were analyzed to determine the changes occurred in Peroxide Value (PV) and Free Fatty Acids (FFA).

Sensory evaluation

The soya peas curry was evaluated at the interval of 3 months for quality and acceptability on a 9 point hedonic scale by semi-trained panellists with score 9 for samples excellent in all respects, while 1 for highly disliked ones (Ranganna, 2000).

Data analysis

All the analysis was carried out in triplicate. The data was analysed statistically to find out standard deviations and significance (Snedecor and Cochran, 1988).

Results and Discussion

Effect of retort processing on RTE soya peas curry

Soya peas curry was prepared as per the recipe standardized by this laboratory and retort processed as prescribed by Code of Federal Regulations. During retort processing, the core temperature of the products, which was measured by thermocouples, was found to increase gradually with the increase of processing time as shown in Figure 2. A reference temperature of 121.1ºC was used to calculate the process lethality for C. Botulinum. A thermal resistance (z) value of 10 obtained for the similar products was used in this calculation. The come up time for soya peas curry to reach 100ºC was 16-17 min. After attaining 100ºC the product was subjected to steam-air mixture (15 lbs + 5 lbs) and the product temperature close to 118ºC in 30-31 min. At, 118ºC the product was held for 3 min. After achieving the desired F_0 value, the product temperature of 118°C was brought to 50-55°C by pressurized water cooling. The time-temperature history curves of the products are shown in Figure 1. The retort processed parameters like heating lag factor, heating rate index, total process time, F_0 values and cook values were reported in Table 2. The retort temperature was maintained 121.1°C for the product. The F_0 value achieved was 5.40. Our results were accordance with other author Frott and Lewis (1994) who studied retort processed meat products and recommended the F_0 value between 8 and 20 min for retort processed meat products. Ranganna (2000) also reported F_0 values between 8 and 12 for meat products. Gopal *et al.* (2001) also processed Kerala style fish curry at 121.1°C to F_0 values of 6.56 min and 8.43 min. The main challenge is to assure product safety during cooling, packaging, and post packaging stages. This requires either additional thermal treatment, or an alternative treatment that has minimal effects on the product's final quality. Thermal processing is one of the important preservation technologies for Ready-to-eat (RTE) food products and can be stored at ambient temperature with minimum one year shelf life.

The retort processed soya peas curry was analyzed for its proximate composition and moisture, protein, fat, and ash values were 76.53 ± 0.54, 32.90 ± 0.07, 23.32 ± 0.09, 1.802 ± 0.002 respectively. The RTE soya peas curry was stored under different temperatures (4-5°C) ambient (27-30°C) and accelerated temperature (45°C) and analyzed for its quality deterioration (Table 4).

Table 1. Ingredient used for the preparations of Soy-peas curry

Soy-Peas Curry	
Ingredients	Weight
Soy Chunks raw (kg)	5.0
Dry Green Peas (kg)	7.0
Onion (kg)	30.0
Tomato (kg)	15.0
Ginger paste (gm)	200.00
Garlic paste (gm)	200.00
Jeera powder (gm)	250.00
Dhania powder (gm)	300.00
Chilli powder (gm)	550.00
Garam Masala (gm)	600.00
Turmeric powder (gm)	350.00
Pepper powder (gm)	250.00
Corn flour (gm)	320.00
Oil (ltr)	8.0
Salt (kg)	1.4
Water (ltr)	35.0

Table 2. Thermal processing parameters for Soya-Peas curry

Parameters	Soya-Peas curry
Retort Temperature (^{0}C)	121.1
Heating lag factor J_h	0.37
Heating rate index f_h min	14.3
Process time (B) min	35.0
F_0 value	5.40
Cook value C_g	60.02

Table 3. Physico-mechanical and barrier properties of multi layer laminate retort pouch

Parameters	Before retort processing	After retort processing
12 µm Polyethylene terephthalate (PET) / 9 µm Aluminium foil / 15 µm Nylon / 70 µm Cast Polypropylene		
Total thickness µm	110	110
Tensile strength (Machine Direction) kg / cm²	448.68	427.30
Tensile strength (Cross Direction) kg / cm²	366	352
Elongation at break (Machine Direction)%	162	138
Elongation at break (Cross Direction) %	128	118
Tearing strength (Machine Direction) g	120	112
Tearing strength(Cross Direction) g	102	96.0
Seal strength (Top) kg /10 mm	4.24	3.98
Seal strength (Side) kg/ 10 mm	4.46	4.16
Seal strength (bottom) kg / 10 mm	4.22	3.96
Gas transmission rate (ml/m²/day)	<0.020	<0.028
Water vapour rate (gm/m²/day)	<0.018	<0.029
Total migration (mg / kg)		
Distilled water	28.0	30.0
3% Acetic acid	36.0	44.0
50% Ethyl alcohol	29.0	32.0
n- Heptane	26.0	28.0

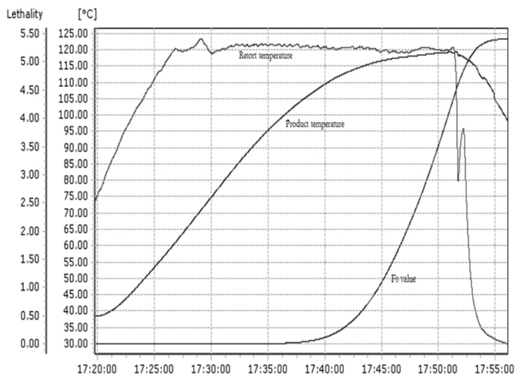

Figure 2. Heat Penetration study of soya peas curry

Effect of retort processing on micro flora in soya peas curry

The microbiological analysis of the soya peas

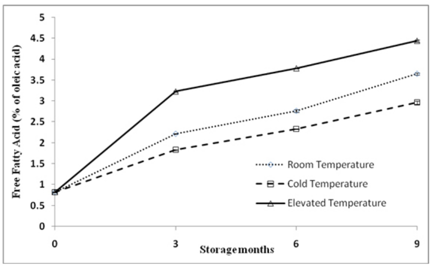

Figure 3. Changes in free fatty acid (FFA) content of retort processed soy-peas curry under different temperature storage

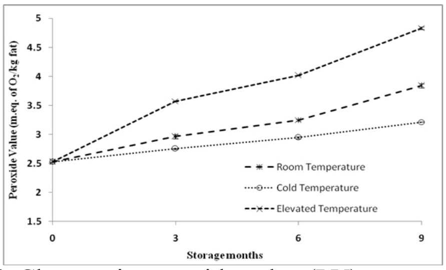

Figure 4. Changes in peroxide value (PV) content of retort processed soy-peas curry under different temperature storage

curry was found to be Nil and also the products remained commercially sterile during the entire period of the storage and confirmed the adequacy of the processing as well as it’s fit for consumption (data not shown). The proper F_0 value of the products rendered the commercial sterility of soya peas curry. Our result were in accordance with authors (Kumar *et al.*, 2007; Agathian *et al.*, 2009; Mohammedali *et al.*, 2013) who studied retort processed ready-to-eat food; they also found commercial sterility after retort processing and the entire period of the storage under different temperature. The results were in agreement with the findings of other researchers. Rajkumar *et al.* (2010) determined total viable, anaerobic, coliform, staphylococcal, streptococcal, clostridial and yeast and mould counts of Chettinad goat meat curry retorted to an F_0 value of 12.1 minutes and showed that the product was commercially sterile.

Effect of retort processing on physico-mechanical and barrier properties of retort pouches

Physico-mechanical and barrier properties of the retort pouches were evaluated before and after processing (Table 3). The pouch material used is similar to or better compared to those used in similar studies. For example it has a water transmission of <0.019 g/m^2. This can be compared with e.g. the 0.18 g/m^2 for the pouches used by Rajkumar *et al.* (2010) and 0.21 g/m^2 for the pouches used by Mohan *et al.* (2008). According to Rajan *et al.* (2011) a low water vapour transmission is an indicator of suitability of the pouches for retort processing. It is also positive for the shelf-life of the product. The strength of the pouch and seal is very critical and important for avoiding bursting during processing or handling. The seal strength is also an indicator of shelf-life (Rajan *et al.*, 2011). The heat seal strength of the pouch used is 3.96 kg/10 mm if a sealing temperature of 220°C is used. This can be compared with the pouches used by Rajkumar *et al.* (2010) which showed a heat seal strength of 5.9-6.5 kg/15 mm. The processing effect on physico-mechanical and barrier properties of retort pouches were also evaluated and found that the effect of processing was insignificant. The packaging system based on aluminium foil has been reported to provide barrier against mass transfer, light and micro-organism and thus the moisture content of the product was almost retained till the completion of storage studies (Ghosh *et al*., 1980).

Changes in free fatty acids (FFA) and peroxide value (PV) during storage

Figure 3 shows that the changes in free fatty acid (FFA) content during storage at different temperature of retort processed soya peas curry had no significant ($P > 0.05$) effect on total acidity. The free fatty acids (FFA) content of soya peas curry increased up to 2.6 ± 0.19 and 3.60 ± 0.100 under ambient temperature (27-30°C) and accelerated temperature (45°C) storage respectively. FFA is the value, which correlates the possibility of breakage of long chain fatty acid chain into individual fatty acid moieties. Our results were in accordance with authors (Aubourg *et al*., 1990; Aubourg *et al*., 1997) who studied the FFA changes in canned processed products. FFA content of the soya peas curry was increased gradually, accelerated temperature (45°C) storage had a higher level when compared to other conditions storage but the increase was within the acceptable level. Increase in FFA content mainly due to the increased lipid hydrolysis at elevated temperature. Kumar *et al.* (2007); Mohammedali *et al.* (2013); Agathian *et al.* (2009) also studied the retort processed ready-to-eat foods; and they also found a slight increase in FFA content at the end of 9th month of storage period but the product was acceptable by the panellist.

The formation of peroxides during storage was slow during induction period, the length of which mostly depends on the nature of fat and the presence of antioxidants. The observation also confirmed that the peroxide value of the product was not increased due to non-availability of oxygen, controlled by the packaging system (Figure 4). Peroxide values of soya peas curry was increased upto 1.21 ± 0.19 and 2.40 ± 0.100 under ambient temperature (27-30°C) and accelerated temperature (45°C) storage

Table 4. Effect of storage at different storage temperatures on proximate composition of soya peas curry

Parameters	Initial analysis	Storage condition								
		5 °C			RT			45 °C		
		Storage period (months)								
		3	6	9	3	6	9	3	6	9
Moisture (%)	76.63 ± 0.54	76.65 ±0.15	76.67 ± 0.13	76.71 ± 0.20	76.58 ± 0.14	76.53 ± 0.54	76.46 ± 0.11	76.54 ± 0.13	76.48 ± 0.10	76.42 ± 0.17
Fat (%)	23.32 ± 0.09	23.29 ± 0.85	23.22 ± 0.90	23.12 ± 1.00	23.26 ± 1.00	23.24 ± 0.05	23.20 ± 0.07	22.95 ± 0.04	22.82 ± 0.07	22.69 ± 0.10
Protein (%)	32.90 ± 0.07	32.86 ± 0.07	31.49 ± 0.01	30.13 ± 0.04	32.23 ± 0.02	30.28 ± 0.12	28.45 ± 0.06	32.16 ± 0.06	29.46 ± 0.10	26.85 ± 0.06
Total ash (%)	1.802 ± 0.002	1.80 ± 0.00	1.807 ± 0.001	1.807 ± 0.003	1.803 ± 0.003	1.805 ± 0.001	1.806 ± 0.004	1.803 ± 0.000	1.804 ± 0.003	1.802 ± 0.002

Mean ± SD

Table 5. Effect of Retort processing on Sensory analysis in Soya peas curry

Parameter	Storage condition	Storage Period (months)			
		Initial	3	6	9
Colour	5°C	8.6 ± 0.32	8.5 ± 0.25	8.5 ± 0.19	8.4 ± 0.20
	RT		8.3 ± 0.10	8.2 ± 0.15	8.0 ± 0.23
	45°C		8.2 ± 0.20	8.0 ± 0.23	7.8± 0.26
Flavour	5°C	8.5 ± 0.36	8.4 ± 0.22	8.3 ± 0.20	8.1 ± 0.24
	RT		8.2 ± 0.18	7.9 ± 0.26	7.8 ± 0.30
	45°C		7.8 ± 0.30	7.2± 0.16	7.0 ± 0.26
Taste	5°C	8.4 ± 0.20	8.3 ± 0.18	8.1 ± 0.15	8.1 ± 0.20
	RT		8.0 ± 0.20	7.8± 0.23	7.5 ± 0.18
	45°C		7.8 ± 0.25	7.4 ± 0.15	7.0 ± 0.26
Texture	5°C	8.4 ± 0.42	8.4 ± 0.28	8.3 ± 0.12	8.2 ± 0.28
	RT		8.2 ± 0.26	7.8 ± 0.20	7.6 ± 0.24
	45°C		7.8 ± 0.12	7.6 ± 0.30	7.2 ± 0.16
Overall acceptability	5°C	8.4 ± 0.23	8.2 ± 0.16	8.2 ± 0.16	8.1 ± 0.21
	RT		8.2 ± 0.22	8.1 ± 0.10	8.0 ± 0.12
	45°C		7.7 ± 0.32	7.5± 0.26	7.2 ± 0.28

Mean ± SD

respectively. The increase in Peroxide value was not much significant ($p > 1.5$) when compared to samples stored under lower temperature (4-5°C). It is clearly indicating that the rancidity development was temperature dependent. Other authors also (Kumar *et al.*, 2007; Agathian *et al.*, 2009; Mohammedali *et al.*, 2013) found a slight increase in the peroxide value of retort processed samples when stored under different storage temperatures. The lipid oxidation was attributed to the combination of free radicals with oxygen and to form hydroperoxides (Gracey *et al.*, 1999). Hence the free fatty acid content of the soya pea curry was less with the non availability of oxygen rendered less production of hydroperoxides in retort pouch processed soya peas curry.

Effect of retort processing on sensory analysis in soya peas curry

The sensory analysis of Soya peas curry using a 9-point hedonic scale (Table 5) revealed that initially the product scored 8.6 ± 0.32 for colour, 8.5 ± 0.36 for flavour, 8.4 ± 0.20 for taste, 8.4 ± 0.42 for texture and 8.4 ± 0.23 for the overall acceptability respectively. On storage the sensory scores of the product were decreased under ambient temperature (27-30°C) and accelerated temperature (45°C) storage conditions. Under ambient conditions the sensory scores decreased to 8.0 ± 0.23 for colour, 7.8 ± 0.30 for flavour, 7.5 ± 0.18 for taste, 7.6 ± 0.24 for texture and 8.0 ± 0.12 for the overall acceptance. At 45ºC, the decrease was 7.8 ± 0.26 for colour, 7.0 ± 0.26 for flavour, 7.0 ± 0.26 for taste, 7.2 ± 0.16 for texture and 7.2 ± 0.28 for overall acceptability of soya peas curry. These results clearly indicating the effect of storage conditions on the quality attributes of the product. Our results were in accordance with Gopal *et al.* (2001) who evaluated Kerala style fish curry and showed an overall acceptance of 8.0 on a 9-point scale rating after heat treatment, which decreased to 7.5 after 12 months of storage. Rajkumar *et al.* (2010) also evaluated appearance, colour, flavour, juiciness, texture and overall acceptability for Chettinad goat meat curry, showing scores of 8.0-8.4 on a 9-point hedonic scale after heat treatment.

Conclusion

Results from the temperature measurements and microbiological tests showed that the product was commercially sterile throughout the storage period. The changes in free fatty acids (FFA) and peroxide value of thermally processed soya peas curry were insignificant and it is possible to develop shelf stable soya peas curry in retort pouches with good quality.

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