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Development of chicken paprika in retort pouches

(Penghasilan ayam paprika di dalam uncang retort)

E. C. Chuah*, O. Abd Malik*, T. Zahrah** and Q. L. Yeoh*

Key words: chicken paprika, retort pouches, storage study, shelf life, quality

Abstrak

Reka bentuk campuran telah digunakan dalam pembentukan formulasi ayam paprika. Produk yang dihasilkan dibungkus di dalam uncang retort. Aroma merupakan faktor penentu untuk mendapatkan penerimaan yang optimum. Walau apa pun jumlah puri tomato dan kanji jagung yang digunakan, formulasi yang mengandungi 10–20% serbuk cili adalah diterima. Kajian penyimpanan selama 12 bulan terhadap produk yang disimpan pada suhu bilik menunjukkan produk selamat dan dapat diterima.

Abstract

Formulations for chicken paprika were developed using mixture design. The product developed was packed in retort pouches. Aroma was the only limiting factor in attaining optimum acceptability. Regardless of tomato puree or cornstarch used, any formulations between 10% and 20% chilli powder were acceptable. Sensory evaluation of the product conducted at monthly intervals showed that the product stored at room temperature was safe and acceptable for at least 12 months.

Introduction

In recent years, consumer demands and trends for food have changed. Consumers are now looking for foods which are perceived to be convenient to use, that is, foods which are ready-to-eat or easy-to–prepare and preferably come in packages that can be easily and quickly heated up and disposed off after the food is consumed, thus saving or reducing time needed for preparing and washing up in the kitchen.

The increasing demand for convenience food is partly due to the increasing numbers of two income families. Thus less time is available in the kitchen for food preparation prior to consumption. Furthermore, as a result of high cost and increasing difficulties in securing domestic help due to more stringent regulations, housewives have to balance their time between family and office commitments. Besides looking for convenience, consumers are also more health-conscious nowadays. They prefer foods that do not contain preservatives and yet receive less heat treatment to minimize nutrient loss.

The consumers' quest for convenience and healthy foods is having a great influence on the type of research on processed meat products. More research work are being carried out to develop such products, perhaps, incorporating the more advanced

*Food Technology Centre, MARDI Headquarters, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia
**Economics and Technology Management Research Centre, MARDI Headquarters, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia
Authors' full names: Chuah Eng Chong, Abd. Malik Othman, Zahrah Talib and Yeoh Quee Lan

processing technologies which minimize heat treatment yet achieve the desired product characteristics. Although technologies such as ohmic heating, pulsed electric field and bright light which are used to destroy microorganisms in foods, the latter two being non-thermal, are being looked into in some advanced countries, local food processors have no such facilities.

One of the technologies currently used by a couple of our local meat processors is the retort pouch technology. Instead of packing into metal cans, the meat product is packed in aluminium laminate pouches. After being vacuum-sealed, the pouches are retorted in an overpressure type of retort to achieve commercial sterility in a much shorter time compared to cylindrical metal cans. This is due to the narrow profile of the pouch which enable the heat to get to the coldest point in the pouch at a faster rate. The reduced heat treatment results in more nutrient retention in the product besides being ready-to-eat with or without prior heating.

However, it must be remembered that apart from convenience, taste is another important criterion used by consumers to select their purchase. Thus a project was carried out to develop an organoleptically acceptable and reduced heat-treated shelf-stable product. The thermal process schedule for low-acid foods packed in hermetically sealed containers is based on the destruction of mesophilic spores of *Clostridium botulinum.*

Materials and methods

Processing

Boneless, skinless chicken breasts (Dinding Poultry Sdn. Bhd) were cut into cubes. The cubed meat was then partially cooked in an oven (Convotherm Elektrogerate) by superheated steam and filled into the pouch. The pouch was then topped up with hot paprika sauces. It was then vacuum sealed and the product retorted at 121 °C in an overpressure retort (Toyo Seikan Kaisha, Model H6) to achieve commercial sterility. The mixture from each paprika sauce formulations *(Table 1)* contained the main ingredients and seasonings.

Experimental design

A three-component constrained mixture according to a symmetrical-simplex interior design was used (McLean and Anderson 1966; Snee 1975) as shown in *Table 1*. The mixture components consisted of tomato puree *(X1)*, chilli powder *(X2)*, and cornstarch *(X3)*. The lower and upper bound restrictions were placed on chilli powder *(X2)* and cornstarch *(X3)* proportions thus limiting the desired mixture to a subregion of the simplex *(Figure 1)*. Ten mixtures were tested. Points 1, 2, 3 and 4 are the vertices of the region under study with 4 interior points i.e. 5, 6, 7 and 8. Point 9 and 10 are two replicated centre point. In each mixture, the proportion of each ingredient varied between 0 and 1 in such that the proportional values of ingredients summed to one ($X1 + X2 + X3 = 1$). The

Table 1. Composition of chicken paprika formulations in a three-component constrained symmetrical-simplex interior design evaluated for acceptability of sensory qualities

Formulation number*	Ingredient (%)		
	X1	*X2*	*X3*
1	0.90	0.00	0.10
2	0.60	0.00	0.40
3	0.20	0.40	0.40
4	0.50	0.40	0.10
5	0.70	0.10	0.20
6	0.60	0.10	0.30
7	0.40	0.30	0.23
8	0.50	0.30	0.20
9	0.55	0.20	0.25
10	0.55	0.20	0.25

*Formulation numbers correspond to the number shown in *Figure 1*

The 3-component mixture of chicken paprika ingredients had subjected to the constrained as stated: $0 <$ tomato puree ($X1$) <1.00,
$0 <$ chilli powder ($X2$) ≤ 0.4, and
$0 <$ cornstarch ($X3$) ≤ 0.40

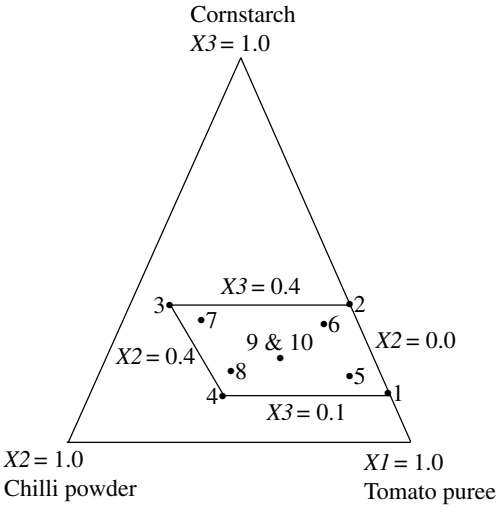

Figure 1. Constrained region in the simplex coordinate system defined by the following restriction: 0.0 < X1 <1.0, 0.0 < X2 ≤ 0.4, 0.1 < X3 ≤ 0.4.
Numbers (1–10) represent ten formulations and correspond to the numbers in ***Table 1***

concentrations of other ingredients were kept constant.

Sensory analysis For sensory evaluations, vacuum packed chicken paprika were dipped in hot water for about 3 minutes. While still warm, the samples were randomly presented to ten panelists (Kramer et al. 1963; Lowe 1963) to evaluate the acceptability of the chicken paprika. The panelists were staff in the Food Technology Centre, MARDI Serdang. Panelists evaluated the samples for colour, aroma, texture, taste, consistency and overall acceptability. Scores were based on a nine-point hedonic scale of 1 to 9 (9 being the highest score).

Statistical and data analysis Multiple regression analysis (SAS Institute, Inc. 1985) was used to fit a quadratic canonical polynomial model describes by Scheffe' (1958) as follows:

$$Yi = B1X1 + B2X2 + B3X3 + B12X1X2 + B13X1X3 + B23X2X3$$

where, *Yi* is the estimated value of the response, *B1, B2, B3, B12, B13* and *B23* are regression coefficients, *X1* is the proportion of tomato puree, *X2* is the proportion of chilli puree and *X3* is the proportion of cornstarch. Because of the restriction of the mixture design (*X1 + X2 + X3* = 1.0), it was not possible to estimate the intercept (bo) and all the linear coefficients (bi). The regression was not full rank. The intercept and parameters such as *X1X1, X2X2*, and *X3X3* were set to zero and thus not included in the models. Adjusted R^2 was also redefined. Analysis of variance (ANOVA) and Duncan's Multiple Range Test was performed to determine differences in acceptability for each sensory attribute and overall acceptability among chicken paprika samples.

Deriving the optimum formulation
Predictive models were used to generate contour plots for overall acceptability, taste, aroma, texture, consistency and colour. The model was fitted to the data for each of the sensory attributes. The estimates of the regression coefficients were obtained by setting the value of the intercept to zero. In each case the best-fitting model for the attributes was chosen. Variables were deleted only if they failed to make significant contribution to the model. The contour lines connecting the response points of equal values, are plotted on the diagram of the contour space. This enables the experimenter to find an optimum blend and a few alternative blends that are of interest. The contour plots for the significant sensory attributes were then superimposed and regions of overlap were identified.

Cold point determination Chicken paprika developed was packed into retail size retort pouches measuring 130 mm x 170 mm. Three thermocouples were inserted into one of the pouches and connected to a ELLAB temperature/F_o recorder (Model CTF 84). Due to size constraints of pouch, only three thermocouples can be inserted

into each pouch at one time. This recorder automatically converts the heat penetration data received into F_o value directly. One of the thermocouples, line 3, was located at the geometric centre (GC) of the pouch while the other two were placed at about 22.5 mm, line 2 and 45 mm, line 1, from the GC. Meat pieces of equal size were inserted to the same depth into each of the thermocouples and the pouch filled to a required solid weight of 100 g. The pouch was then topped up with 80 g of the paprika sauce and the pouch vacuum-sealed. The pouches were then placed into separate compartments in the retort trays and the product retorted at 121 °C to achieve commercial sterility, based on the lowest sterility value obtained as given by one of the thermocouples.

Heat treatment A batch of the product was produced for storage studies and retorted to achieve commercial sterility. However, only one thermocouple was inserted into one of the pouches at the cold point previously determined to establish the F_o value.

Microbiological examination

Immediately after retorting, duplicate samples of the product were incubated at 37 °C for 14 days and at 55 °C for 7 days respectively. The pouches were examined at frequent intervals during the incubation period for signs of swelling and removed if present. At the end of the incubation period, the pouches were tested for commercial sterility. The product was also examined at the end of the storage period, and in this case no incubation of the pouches was necessary before examination was carried out.

Standard microbiological methods were used for examination of the product (Speck 1976; Harrigan 1998). Duplicate samples were analyzed. The samples were tested for presence of mesophilic and thermophilic aerobes and anaerobes. Approximately 10 g of the meat from core areas was aseptically sampled. It was blended with 90 mL sterile quarter strength Ringer's solution for 2 min using a Stomacher Lab Blender 400. Using aseptic techniques, 1 mL samples were inoculated into the various plates and tubes. For the aerobes, total plate count agar (TPCA) was used whereas for the anaerobes, TPCA in tubes layered with sterile agar were used. The plates and tubes were incubated at 32 °C and 55 °C respectively for 48–72 h and examined for formation of colonies.

Storage studies and sensory analysis

Selected formulation from optimization was used for storage studies. Samples were produced as described earlier and stored at room temperature for 12 months. Sensory evaluations were done as described earlier. Data were collected using a randomised complete block design (Cochran and Cox 1956). Mean score of the hedonic scale rating for each attribute was evaluated using PROC Means SAS Package (SAS Institutes Inc. 1985). The sensory evaluation studies of the product were carried out monthly over 12 months.

Results and discussion

Experimental design

There were significant differences (p <0.05) in overall acceptability (OA), taste, aroma, colour and consistency for the formulations *(Table 2)*. The colour was accepted with lesser chilli powder used in the formulations. The OA and taste of formulations 1, 5, 6, 9 and 10 were most liked. Formulation 3 received the lowest score in OA, taste, and aroma while formulation 2 has the lowest score in consistency and colour. It was found that formulations 3 and 4 were too hot.

Sensory analysis

Overall acceptability Chilli powder (CP) and cornstarch (CS) *(Table 2)* influenced the overall acceptability. The ratings for satisfaction or overall acceptability of a food are not only based on intrinsic sensory

Table 2. Mean sensory score for overall acceptability, taste, aroma, texture, consistency and colour for chicken paprika

Formulation number*	Mean sensory score and Duncan Multiple Range Test					
	Overall acceptability	Taste	Aroma	Texture	Consistency	Colour
1	6.24ab	6.28abcd	6.00abc	6.68a	6.20bcd	5.84cd
2	5.92bc	5.96bcde	6.12ab	6.88a	5.88d	5.72d
3	5.40c	5.28e	5.32d	6.68a	6.24abcd	6.28abcd
4	5.64bc	5.28e	5.68bcd	6.48a	6.16cd	6.40abc
5	6.56a	6.68a	6.16ab	6.72a	6.36abcd	6.04bcd
6	6.64a	5.48abc	6.32a	6.92a	6.76ab	6.88a
7	5.88bc	5.88cde	5.60bcd	6.76a	6.80a	6.48ab
8	5.84bc	6.68de	5.48cd	6.88a	6.44abcd	6.68a
9	6.28ab	6.20abcd	6.00abc	6.92a	6.44abcd	6.48ab
10	6.64a	6.60ab	6.20abcd	6.80a	6.72abc	6.76a

*Formulation numbers correspond to the numbers shown in *Figure 1* and *Table 1*
A 9-point hedonic scale was used (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely)
Different alphabets in the same column indicate significant difference at ($p \leq 0.05$)

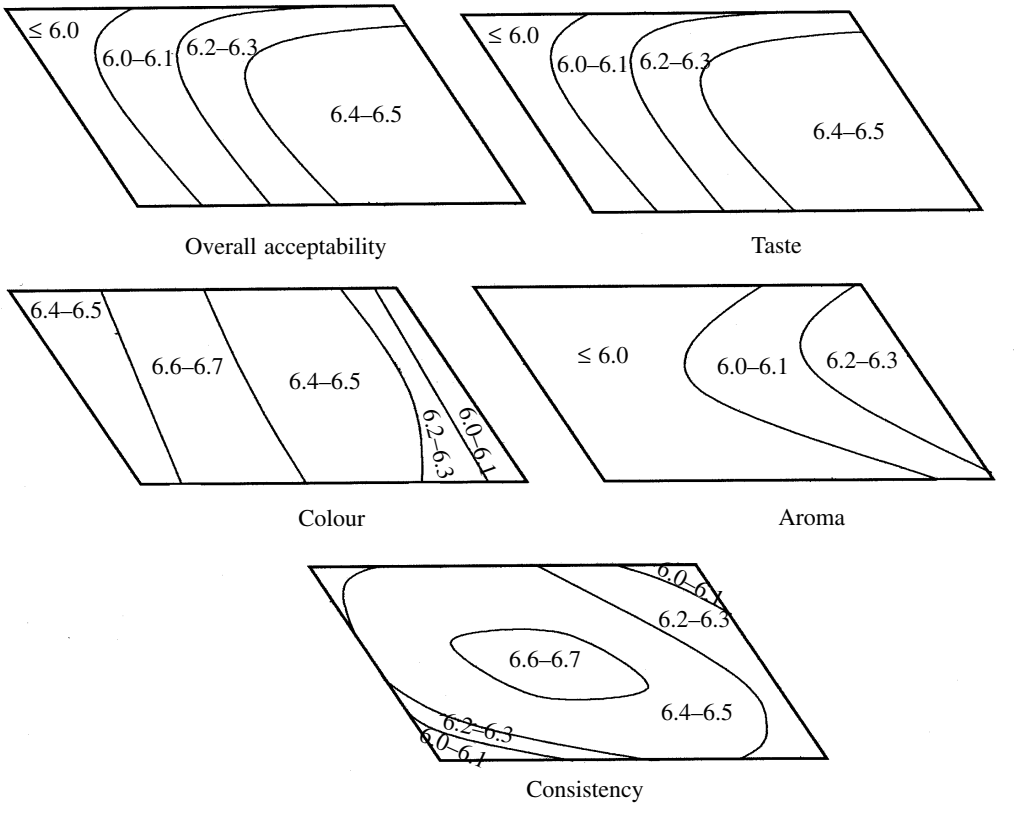

Figure 2. Contour plots for predicted acceptability values of overall acceptability, taste, colour, aroma and consistency. See Figure 1 for coordinate (X1, X2, X3) and formulation numbers

characteristic, but also the degree to which the product meets sensory and hedonic expectations (Cardello 1994). Increasing CP and CS to chicken paprika formulations decreased overall acceptability scores *(Figure 2)*. Formulation containing 40% CP and 40% CS was unacceptable (score = 5.4). Chicken paprika containing a mixture of 10% CP and 30% CS or 20% CP and 25% CS was most acceptable.

Taste and aroma The mean scores for taste and aroma were affected by CP. Chicken paprika containing >20% CP was unacceptable (score = <6.0). This was due to the panelists describing the taste and aroma of chicken paprika as hot.

Texture There were no significant differences between texture of the 10 formulations at p <0.05. The texture of chicken paprika was highly acceptable (score = >6.48).

Consistency and colour Non addition of CP and maximum addition of CS resulted in the lowest score (<5.88) of consistency and colour. Maximum addition of CS in chicken paprika made the sauce consistency thicker whilst non-addition of CP was not acceptable.

Optimization

In sensory evaluation, optimization is defined as a procedure for developing the best possible product in its class (Sidel and Stone 1983). An optimal formulation should maximize panelist acceptance of a given set of ingredients (Fisken 1983). In most applications, it would be impossible to develop a product with all desirable sensory qualities that would satisfy panelists, but it should be possible to approach that result (Moskowitz 1994). Formulations that were rated 6.0 or higher for overall acceptability, taste, aroma, texture, consistency and colour were used to derive an optimum. Superimposing acceptable areas of contour plots revealed that aroma was the only limiting factor in attaining optimum. All formulation combinations (shaded area, *Figure 3*), containing <20% of CP predicted to produce products with an aroma score ≥6.0. Regardless of tomato puree or cornstarch used, any formulation between 10% and 20% chilli powder would yield a product with predicted acceptability score >6.0 for aroma and colour, and score >6.28 for consistency and overall acceptability.

Three formulation mixtures were selected to test the reliability of the model (*Table 3* and *Table 4*). It was found that a mixture with 60% TP, 20% CP and 20% CS would give a mean sensory score of more than 6.68 for all sensory attributes tested.

Heat penetration studies

Cold point determination *Figure 4* shows the heat penetration data recorded by the three thermocouples. The sterility value (F_o value) obtained showed that the cold point of the product was at the GC of the pouch, as shown by line 3 in *Figure 4*. At this location, the F_o value obtained was 12.5. The F_o values of the other two locations, indicated by lines 2 and 1 were 13.21 and 14.02, the latter being the furthest from the GC. This shows that the heat penetration into the pouch was by slow conduction. From *Figure 4*, it can be seen that heating rate of the product at the three thermocouple locations was about the same.

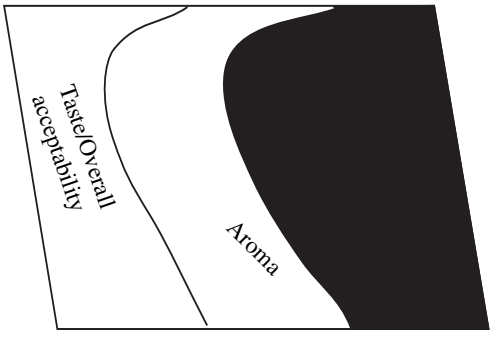

Figure 3. Optimum region (shaded) tomato puree (X1), chilli powder (X2) and cornstarch (X3) that would yield chicken paprika with acceptable sensory qualities (score ≥ 6.0 on a 9-point hedonic scale)

Table 3. Reduced quadratic canonical polynomials for each dependent sensory attributes and overall acceptability of chicken paprika containing proportions of tomato puree (*X1*), chilli powder (*X2*) and cornstarch (*X3*)

Dependent variables (Y)	Predictive model	Adjusted R^2
Overall acceptability	Y = 5.97*X1* + 7.03*X1X2* + 10.42*X1X3* + 17.20*X2X3*	0.9987
Taste	Y = 6.08*X1* + 7.11X1X2 + 10.03*X1X3* + 16.35*X2X3*	0.9984
Aroma	Y = 5.50*X1* + 4.62*X2* + 11.98*X1X3* + 8.24*X2X3*	0.9988
Consistency	Y = 5.80*X1* + 8.72*X1X2* +10.15*X1X3* + 22.57*X2X3*	0.9991
Colour	Y = 5.77*X1* + 6.08*X3* + 12.54*X1X2* + 10.64*X2X3*	0.9981

Sensory scores were based on a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely).
R^2-adjusted = 1- [{(n – i)(1 – R^2)}/(n – p)], where I = 0 for non-intercept regression model, n = the number of observations used to fit the model, and p = the number of parameters in the model (SAS Institute, Inc. 1985)

Table 4. Mean sensory scores of selected formulations for overall acceptability, taste, aroma, texture, consistency and colour for chicken paprika

Formulation number*	Overall acceptability	Taste	Aroma	Texture	Consistency	Colour
1	6.64a	6.96a	6.64a	6.92a	7.12a	6.92b
2	6.84a	6.68ab	6.80a	7.18a	6.92a	7.28a
3	6.32b	6.28b	6.28b	6.84a	6.78a	6.48c

*Formulation numbers where; 1: *X1* = 0.72, *X2* = 0.06, *X3* = 0.22
2: *X1* = 0.60, *X2* = 0.20, *X3* = 0.20
3: *X1* = 0.50, *X2* = 0.13, *X3* = 0.37
A 9-point hedonic scale was used (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely)
Different alphabets in the same column indicate significant difference at $p \leq 0.05$

This could be due to the small surface area of the pouch and closeness of the thermocouples. As the size of the retort pouch was relatively small, it was only possible to place the three thermocouples from the GC as it would be very difficult to place the thermocouples close to the base of the pouch due to the size of the packing gland and the distance piece attached to the inside of the pouch.

On the other hand, the rate of cooling was much faster at the GC. As a result of this, the sterility value did not increase as much as the two other thermocouple locations. As the formulation of the product contained starch, the heat was probably transmitted via conduction thus resulting in the cold point being at the GC. Their respective initial temperatures (IT) were 44.3 °C, 45.1 °C and 44.4 °C when the product was retorted at 121 °C for 24 minutes with a come-up-time (CUT) of 6 minutes.

Heat treatment The batch of product with an IT of 38.8 °C and CUT of 12 minutes when retorted at 121 °C for 24 minutes, resulted in an F_o value of 14.5.

Microbiological examination
Meat and meat products are highly perishable commodities, and need to be properly processed and stored. The main cause of spoilage and deterioration is usually due to microbial growth. Thus it is important to evaluate the effectiveness of the heat treatment given.

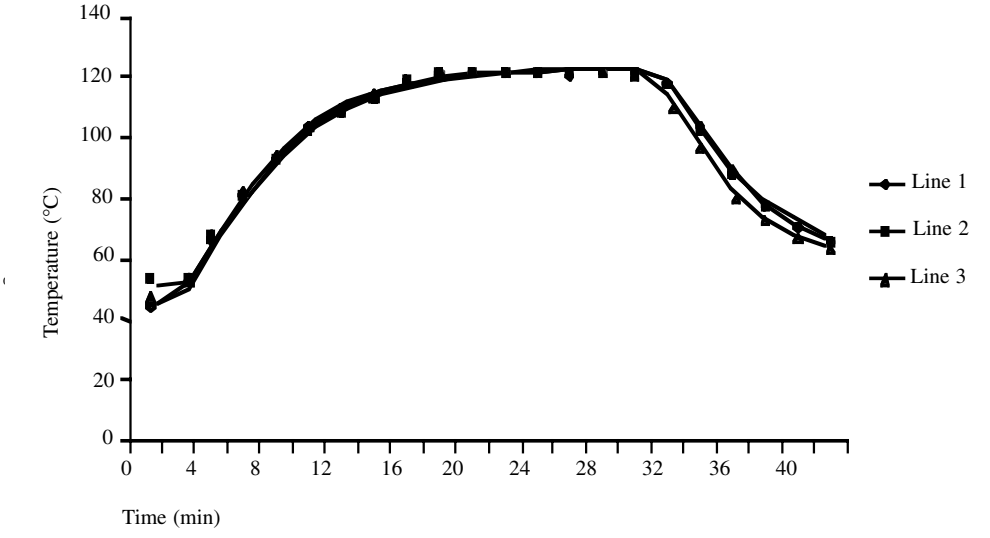

Figure 4. Heat penetration data of chicken paprika as indicated by line 1, line 2 and line 3 in the retort pouch where line 3 is the geometric centre (GC), while line 2 and line 1 were placed at about 22.5 mm and 45 mm from the GC respectively

Table 5. Mean scores of six sensory attributes of selected chicken paprika

Month	Colour	Aroma	Texture	Taste	Consistency	Overall acceptability
0	7.20ab	7.00a	7.10a	6.80ab	7.40a	7.00a
1	7.10ab	6.40a	6.80ab	7.00 a	7.00a	6.80ab
2	7.10ab	6.60a	7.10a	6.50ab	6.80a	6.20ab
3	7.20ab	6.50a	6.80ab	6.30ab	6.90a	6.50ab
4	6.90ab	6.10a	6.70ab	6.20ab	6.80a	6.40ab
5	6.90ab	6.60a	6.70ab	6.40ab	6.90a	6.65ab
6	7.10ab	6.60a	6.70a	7.00ab	7.10a	7.00a
7	7.40ab	6.70a	6.90ab	6.90a	7.10a	7.00a
8	7.00ab	6.20a	7.10a	6.30ab	6.80a	6.40ab
9	6.70b	6.40a	6.50ab	6.70ab	6.90a	6.60ab
10	7.20ab	6.50a	6.10b	6.00b	6.70a	6.10b
11	7.10ab	6.40a	6.70ab	6.44ab	7.30a	6.60ab
12	7.60a	6.70a	6.90ab	6.50ab	6.70a	6.50ab

Different alphabets in the same column indicate significant difference at $p \leq 0.05$

Microbiological examination was conducted on the product immediately after processing and repeated on the product that had been stored at room temperature for 1 year. The results showed that no microorganisms were detected in all samples and tests. This indicated that the products were commercially sterile and that the retorting process given was adequate. The effectiveness of the heat treatment given is affected by many factors such as initial microbial load, composition of the product and the fill of the pouch. The thermal process given should be sufficient to destroy all *Clostridium botulinum* spores, pathogenic bacteria and all other microorganisms that can cause spoilage under normal storage conditions. For products that are to be stored

and distributed under tropical conditions, it has been recommended that an F_o value of 12–15 should be given compared to an F_o value of 4–6 for temperate countries (Anon. 1998). Thus it can be seen that the F_o given is sufficient to produce a safe product.

This study showed that the thermal process given was sufficient to produce commercially sterile products. Based on the microbiological examination of the samples, it was found that the shelf life of the product under the packaging and storage conditions described above is at least 12 months.

Storage studies and sensory analysis

The sensory analysis of the chicken paprika was still highly acceptable after 12 months of storage at room temperature. There was no significant difference throughout the storage studies on aroma and consistency *(Table 5)*. Mean scores of all sensory attributes were ≥6.00 on a 9-point hedonic scale. This was true as stated in an optimum region *(Figure 3)* where chicken paprika would be acceptable. On the whole, there was little variation on all sensory values tested indicating that chicken paprika was stable during storage studies.

Conclusion

From the above study, it was found that an acceptable formulation for the product was developed using mixture design. The processing parameters for a commercially sterile product were also established. It can also be concluded that paprika chicken packed in retort pouches that was developed, remained highly acceptable up to at least one year.

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