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Development and evaluation of ready-to-eat cabbage kofta curry

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Abstract
The aim of the study was to develop and stabilizeReady-To-Eat (RTE)Cabbage kofta curry. The RTE cabbage kofta curry was prepared, stabilized using thermal processing technique and stored at ambient (25±2^{0}C) and refrigerated (5^{0}C) temperatures and was analyzed initially and after 15 days. The developed product was packed in metalized polymeric film. The product was evaluated for sensory, proximate, functional, quality and microbial parameters. The product had 30% moisture, 6.03% protein, 14.03% fat, 47.94% carbohydrate, 0.83%fibre and 0.97% ash. The sensory scores decreased during storage period and the product was found to be stable up to 15 days of storage at ambient temperature.

Keywords: cabbage, ready-to-eat, kofta curry, proximate composition, nutritional evaluation, functional components, stabilization

1. Introduction

Cabbage (*Brassica oleracea var. capitata*) is the most important vegetable grown worldwide. Its family is named as *Cruciferae*, which includes broccoli, cauliflower, and kale. The different cultivated types of cabbage show great variation in respect of size, shape and colour of leaves as well as the texture of the head (Singh *et al.*, 2006) [16]. Cabbage *(Brassica oleracae var. capitata)* possess significant amount of vitamins, minerals and dietary fibre, with low fat and calorie contents, revealing it as a vegetable of promising nutritional value (Ogbede *et al.*, 2015) [10]. It has the ability to accumulate high concentrations of metals in its edible leaf that can be exploited in pharmaceutical industries to make capsules or tablets which can supply considerable amount of the recommended daily intake of these elements, with the advantage of using a natural plant source. It can also be exploited in industries for the removal of toxic and heavy metals found in high concentration in contaminated soils (Ogbede *et al.*, 2015) [10]. The main constituent of cabbage is carbohydrates, comprising nearly 90% of the dry weight, where approximately one third is dietary fibre and two thirds are low-molecular-weight carbohydrates. Other characteristic components are glucosinolates (Mathias *et al.*, 2004) [9]. *Brassica* vegetables represent a major part of the human di*et al*l over the world providing nutritionally significant constituents, suchas phenolics compounds, vitamins, fiber, solublesugars, minerals, fat, and carotenoids. Cruciferous vegetables are a source of some very promising chemopreventive dietary constituents who may protect against free radical damage and LDL oxidation implicated in the pathogenesis of cardiovascular diseases, as well as DNA damage and cancer. This might be useful information from the point of view of identifying appropriate raw materials rich in these protective components, for the development of safe food products and additives with appropriate antioxidant properties (Jahangir *et al.*, 2009) [8].

Ready-to-Eat (RTE) food, as the name indicates the food is ready to consume without any additional cooking or preparation. Canned foods, convenience foods, fast foods, frozen foods, instant products, dried foods, preserved foods, etc. all come under Ready-to-Eat foods category. Demographic variables and socio-economic characteristics of the consumers are all important variables, which decide the consumption pattern of food products in the family. Factors which influence the consumer to choose RTE foods are flavor, texture, appearance, advertising, a reduction in traditional cooking, fragmentation of family. Other factors which positively influence Ready-to-Eat food demand are rising income level, influence of western countries, more global trade, travelling, convenience in preparation due to the lack of time and cost effectiveness (Selvarajan, 2012).

According to an author Leistner, foods preserved by combined methodsviz, blanching, drying, addition of preservatives and in pack pasteurization, remain stable and safe even without refrigeration, and are high in sensory, and nutritive properties due to the gentle processes applied. Thus, this concept is gaining ground in industrialized as well as in developing countries (Leistner, 1992) [7].

Blanching is one of the primary processing techniques which are used in preserving the food product from contamination and to extend the shelf life of the product. Drying is a process in which moisture is removed from a food using heat as the energy input. The mechanism of drying involves combined heat and mass transfer and, in most cases, changes the properties of products. It is obvious that drying itself is an energy-intensive process because the latent heat has to be supplied to the material to evaporate the moisture. Preservatives help to retain the keeping quality of fruits and vegetables for a longer period of time, decrease the microbial activity, reduce browning and improve the sensory characteristics.

Brassica vegetables are important sources of dietary mineral, vitamins and most importantly phyto-chemicals. Therefore, an attempt was made to develop a new variety of food product from cabbage (*Brassica oleraceae var. capitata*). Since cabbage is rich in moisture the storage period of fresh vegetable is shorter, thus in the present study

RTE cabbage kofta curry was developed, which helps to store for longer period. The developed product will be richer in nutrients and also it is beneficial for working women to use it conveniently.

2. Materials and Methods

2.1 Materials

Fresh samples of cabbage (*Brassica oleracae var. capitata)* and other ingredients for the product development were purchased fromthe Mysore market, Mysuru.

2.1.1 Product development

Development of RTE Cabbage Kofta curry was developed with combination – preservation technology. Procedure for the development is as follows

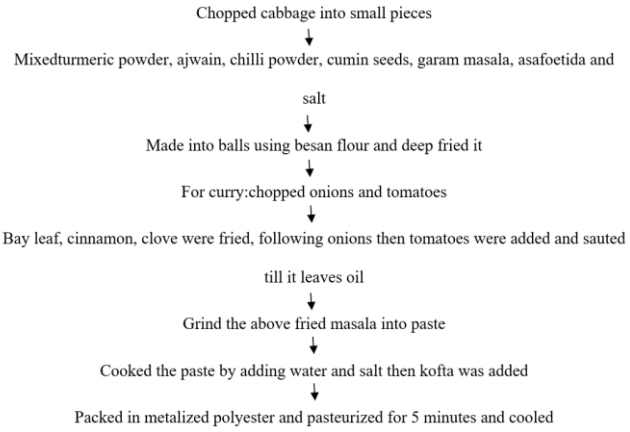

Fig 1: Processing Method for the Development of Ready-To-Eat Cabbage Kofta Curry.

2.2 Analytical profile

Analysis was carried out in the laboratory to determine the proximate, minerals, vitamins, quality and functional compositions. The proximate composition which includes moisture by AOAC (1990) [1], crude protein, crude fat, ash by Ranganna (2010) [11], and carbohydrate were determined by difference method. B-vitamins (thiamine, riboflavin, pyridoxine) were determined by using SKALAR continuous flow analyzer which follows standard AOAC method (1995). Vitamin C was estimated by the method as described in Ranganna (2010) [12].

The functional components such as total phenolics was estimated as per the method described by Singleton and Rosi (1965), Total Flavonoids by Zhishen *et al*., (1999), whereas antioxidants activity was measured by DPPH assay described by Gorinstein *et al*, (2004).

Quality parameters such as titrable acitdity concentrations was found out by the method described by Ranganna (2010) [13], Peroxide value by AOCS method (1999), TBA value in methanolic extracted sample by Tarledgis (1960).

3. Results and Discussion

3.1. Proximate composition:

The result in Table 1 below showed the moisture content 30.2% which is very much less when compared to raw cabbage moisture content i.e., 90% since the cabbage has been fried in the form of koftas. The ash content which is a measure of the inorganic matter of the sample was found to be 0.97%. The sample contained 14.03% crude fat, which is higher when compared to raw cabbage's fat content, it is because the oil has been added during the product development. Fats and oils in diets are the major sources of energy (Levin *et al*., 2009).

The protein concentration of the developed product analyzed was 6.03% making the product as a fair source of protein. The crude fibre content of the cabbage kofta curry was found to be 0.32%. Dietary fiber is an important constituent in *Brassica oleracae var. capitate* and other vegetables of the *Brassica* family (Rodriguez *et al*., 2006), whereas carbohydrate concentration was found to be 47.94%. The key role of carbohydrate in the body is the provision of energy and low level of carbohydrate in fruits and vegetable has been reported to be beneficial for diabetic patients and individuals watching weight (Agoreyo *et al.*, 2012)

Table 1: Proximate composition of RTE Cabbage Kofta Curry

Parameters	Composition (%)
Moisture	30.2
Carbohydrate	47.94
Crude fat	14.03
Protein	6.03
Crude fibre	0.32
Ash	0.97

3.2. Mineral compositions

The result for mineral analyses of the developed product is shown in (Figure 2). The calcium content was found to be 25mg/100g. The value indicate that this vegetable product can contribute meaningful amount of dietary calcium which is needed for growth and maintenance of bones, teeth and muscle, and as such may be used as supplements in diets low in calcium ion (Dias and Joao. 2012) [5]. The concentration of iron in the developed product was analyzed to be 20mg/100g.

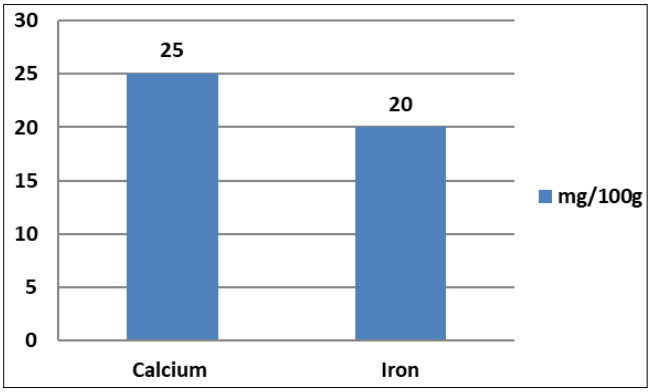

Fig 2: Concentration of Iron and Calcium of RTE Cabbage Kofta Curry

3.3. Vitamins content

The vitaminC content of the developed product is low i.e, 5.17mg/100g when compared with the raw cabbage concentration i.e, 19.22mg/100g, it is because vitamin C is very sensitive to light and heat, therefore due to cooking the vitamin C has been lost. Vitamin B concentrations thiamine 0.7mg/100g, riboflavin 4mg/100g and pyridoxine 0.3mg/100g arefairly good when compared with the raw cabbage concentrations i.e, thiamine 0.0mg/100g, riboflavin 0.1mg/100g and pyridoxine 0.63mg/100g.

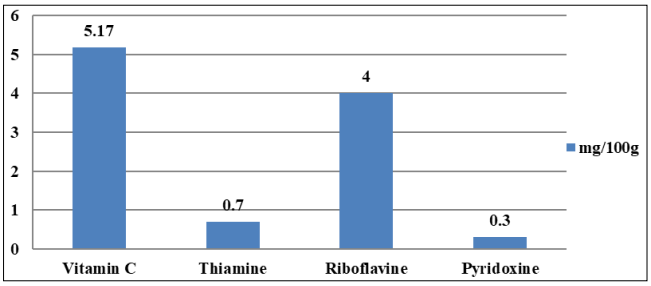

Fig 3: Vitamins Concentration of the RTE Cabbage Kofta Curry

3.4. Functional parameters

Functional parameters such as total phenolics concentrations were analyzed to be 280mg/100g, whereas Total Flavonoids concentration was 40.0mg/100g. The anti-oxidant profile of the Cabbage kofta curry was analyzed to be 87% inhibition.

Table 2: Functional Composition of the RTE Cabbage Kofta Curry

Parameters	Composition
Total phenolics (expressed asgallic acid equivalents/100ml)	280.0 mg/100ml
Total Flavonoids (expressed as catechin equivalents/100ml)	40.0 mg/100ml
Anti-oxidants (Inhibition %)	87.0

3.5. Quality parameters

Quality parameters included titrable acidity, peroxide value, thiobarbituric acid, free fatty acid and the concentrations obtained from the analysis of the developed cabbage kofta curry was 0.8%, 1.6 (millieq O_2/kg of fat), 0.16 (mg malonaldehyde/kg) and 0.11 (%Oleic acid) respectively.

Table 3: Quality Parameters of RTE Kofta Curry

Parameters	Composition
Titrable acidity (%)	0.8
Peroxide value (millieq O_2/kg of fat)	1.6
Free fatty acid (%Oleic acid)	0.11
Thiobarbituric acid (mg malonaldehyde/kg)	0.16

4. Storage studies of RTE Cabbage Kofta Curry

Cabbage Kofta Curry was stored at ambient temperature (25±2^{0}C) as well as refrigerated temperature i.e., 4°C and it was analyzed for every 15days of storage for functional, quality and sensory parameters. Microbial analysis was also carried out for the stored product.Total phenols (mg/100mlgallic acid equivalents), anti-antioxidant (Inhibition %) and total flavonoids (mg of catechin equivalents/100g) were considered as functional parameters, vitamin C (mg/100gm) as nutritional parameter, and pH, titrable acidity, free fatty acids, peroxide value and TBA value were considered as quality parameters, sensory evaluation for overall acceptability and microbiological studies were studied in the stored samples. During the storage period, the functional parameters, quality parameter and sensorial parameters values decreased but it was under acceptable range.

4.1 Functional parameters

Total phenols (mg/100mlgallic acid equivalents), total flavonoids (mg of catechin equivalents/100g) and anti-oxidant profile (Inhibition %) was considered as functional parameters. Changes during the storage period on functional parameters are presented in Table 4. In the initial total phenols of RTE Cabbage Kofta Curry was 280mg/100g of the sample. Total phenol content decreased from the level of 280mg/100g to 200mg/100g in refrigerated temperature and 280mg/100g to 160mg/100g in room temperature. In the initial total flavonoids of RTE Cabbage Kofta Curry was 40mg per 100gm of sample. Total flavonoid content decreased from the level of 40mg to 35mg in refrigerated temperature and 40mg to 30mg at room temperature per 100gm.In the initial the anti-oxidant profile (% inhibition) of RTE Kofta Curry was 87%. The anti-oxidant profile of the cabbage processed products decreased from 87.0% to 35% at room temperature and 87.54% to 50% at refrigerated temperature.

4.2 Nutritional parameter

Vitamin C (mg/100g) was considered as nutritional parameter. Vitamin C is unstable to light and heat; hence the dietary recommendation is double the requirements of the body. In the present study, in the initial the vitamin C content of RTE Cabbage Kofta Curry was 5.17mg per 100g. The vitamin C content decreased from 5.17 to 4.0mg at refrigerated temperature and from 5.17mg to 3.12mg in room temperature.

Table 4: Storage Stability Study of RTE Cabbage Kofta Curry on Functional Parameters

Functional parameters	Storage time (days)	Storage temperature (°C)	RTE Curry
Total phenol (mg/100ml gallic acid)	0	-	280±12.45
	15	5	200±16.34^a
		25 ± 2	160±8.45^c
Flavonoid (mg/100ml quercetin)	0	-	40±3.21
	15	5	35±1.87^b
		25 ± 2	30±2.16^a
Antioxidant (I%)	0	-	87.0±3.45
	15	5	50±2.43^a
		25 ± 2	35±1.78^b

Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

4.3 Quality parameters

In the present study the pH does not vary considerably. The pH of RTE curry is given in Table 5 of both room temperature and refrigerated temperature. Titrable acidity is expressed as % oleic acid was found to be increased in the stored cabbage processed product. In the initial titrable acidity of RTE Cabbage Kofta Curry was 0.8% per 100g of sample. Titrable acidity increased from 0.8% to 1.0% at room temperature and from 0.8% to 0.9% at refrigerated temperature. Peroxide value showed increase in RTE Kofta Curry i.e, from 1.0 to 1.6 and it is expressed as milli eq O_2/kg of fat. The peroxide value of RTE cabbage Kofta Curry is shown in Table 5. It was observed that there was increase in free fatty acid (%/gm) value. The value of free fatty acid was seen in higher percentage in the RTE cabbage KoftaCurry. RTE Cabbage Kofta Curry showed an increase in TBA values (mEqO_2/gm) during storage. In the initial the TBA value of RTE Cabbage Kofta Curry was 0.16 per 100g of sample. The value increased from 0.16 to 0.45 at room temperature and from 0.16 to 0.40 at refrigerated

temperature.

Table 5: Storage Stability Study of RTE Cabbage Kofta Curry on Quality Parameters

Quality parameters	Storage time (days)	Storage temperature (^{0}C)	RTE Curry
pH	0	-	6.93±0.56
	15	5	6.89±0.76^b
		25 ± 2	6.90±0.87^a
Titrable Acidity (%Oleic acid)	0	-	0.8±0.06
	15	5	0.9±0.08^b
		25 ± 2	1.0±0.07^a
Peroxide value ($MeqO_2$/g)	0	-	1.0±0.13
	15	5	1.6±0.45^a
		25 ± 2	1.9±0.56^a
Free fatty acid (%/g)	0	-	0.11±0.07
	15	5	0.15±0.08^a
		25 ± 2	0.20±0.09^b
TBA (mg/molanaldehyde/kg)	0	-	0.16±0.02
	15	5	0.40±0.08^d
		25 ± 2	0.45±0.03^b

Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

4.4 Sensory parameters

Overall acceptability is the sum of different quality attributes which have a bearing on consumer perception towards the acceptance or rejection of a product. The results in the changes in sensory parameters during storage of RTE Cabbage Kofta Curry are given in Table 6.

In this study, the products were served to 25 semi-trained panel members. Samples were randomly drawn for each experimental block, coded, and served to the semi-trained panelists. They have tasted the mushroom products and rated for their organoleptic characteristics in terms of colour, aroma, taste, texture, and overall acceptability on a 9-point hedonic scale. The initial over all acceptability of RTE Cabbage Kofta Curry was 8.28 based on 9-point hedonic scale ratings. The sensory quality of the product decreased due to storage. In general, any product with the score of below 6 is on the non-acceptance. Though the product was acceptable during storage, the temperature of storage influenced the scores.As the storage period increased, overall acceptability decreased.

Table 6: Storage stability study of cabbage processed products on Sensory Score (n=25)

Samples	Storage temperature (^{0}C)	Storage period (days)	Appearance	Colour	Aroma	Texture	Taste	OAA
RTE Cabbage Kofta Curry	-	0	8.19±0.47	8.32±0.60	7.99±0.62	8.14±0.54	8.31±0.41	8.28±0.46
	5	15	8.04±0.48^a	7.95±0.76^c	7.94±0.63^c	7.94±0.69^c	7.84±0.58^a	7.50±0.55^a
	25 ± 2	15	7.32±0.58^a	7.32±0.59^b	7.32±0.60^b	7.32±0.61^b	7.32±0.62^c	7.32±0.63^c

OAA- over all acceptability

Values with different superscripts are significant difference with initial period at the level, a: p>0.0001, b: p<0.001, c: p<0.01, d: p<0.05.

4.5 Changes in Microbial Quality

Microbial growth during storage will depend on the preservation conditions (Gram and Dalgaard 2002) [4]. The RTE curry samples were subjected to bacterial; yeast and mold count every 15 days of storage. All the samples showed no significant mold growth. The samples confined to permissible limit of microbial count of 1000/10000. The microbiological analysis clearly shows the sterilized condition of the product, Coliform was nil upto 15 days of storage period reflecting the safety of the product. After 15 days of storage the product got spoilt, due to its moisture content the microbial load became high and it became unacceptable.

5. Conclusion

The study brought Ready to Eat Cabbage Kofta curry, that is prepared using combination processing technology which was highly acceptable and had rich nutritional value. This type of product is easy to store, easy to serve and easy to be eaten hence this product save one's time as well as their energy. It is very ideal that working women will surely tend to look upon RTE based product which will help her to save time if her cooking process in some way or other. The product has been well designed considering the shelf life, safety, and organoleptic properties. The biochemical and sensory qualities indicated that the cabbage product was in good condition up to 15 days of storage.

6. Acknowledgement:

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