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Plant Protein Sources as an Ingredient in Ready to Eat Veggie Burgers: Nutritional, Sensory and Physicochemical Properties Evaluation

[1]P.H.G.J. De Silva, [2]A. Kalubowila and [2]N. Lalantha
[1]Department of Agricultural Systems, Faculty of Agriculture, University of Rajarata, Puliyankulam, Anuradhapura, Sri Lanka
[2]Keells Food Products PLC, Ja-Ela, Sri Lanka

Abstract: Veggie burger is a convenient processed food product prepared completely from non-meat ingredients usually based on plant protein sources such as soy flour, wheat flour and rice flour. Physical, chemical, microbial and sensory changes of newly formulated veggie burger prepared from rice flour wheat flour with (RW5E) and without (RI0E) fat emulsion, rice flour Isolated Soya Protein (ISP) with (RI5E) and without (RI0E) fat emulsion were periodically analyzed during frozen storage at -18°C for 90 days. Sensorial characters were altered with fat emulsion and rice flour wheat flour addition ($p<0.05$). RW5E was the best sample based on sensory score rating remained between good and very good. Further proximate analysis revealed that RW5E had gained 51.68% moisture, 8.38% fat, 48.33% TS, 36.84% ONF and 3.1% ash after 90 days of storage and RW5E was the best option to lessen purge and increase WHC followed by others. The results of microbial, pH and peroxide value indicated that all 4 products were well with in the recommended standards. This study was indicated that the addition of RW5E to veggie burger exhibited reasonable shelf life and acceptable in terms of nutritional value and sensory merits.

Key words: Veggie-burger, chickpea, rice flour, wheat flour, ISP, Sri Lanka

INTRODUCTION

In today's world, there has been market trend derived towards convenient foods because consumers lead increasingly busy lives (Lawrie, 1979). Among ready to serve foods, hamburgers are acceptable (Egbert *et al*., 1991). Menkhaus *et al*. (1993) indicated that consumer concerns regarding beef products were related to cholesterol and high price. Trindade *et al*. (2007) have mentioned typical composition of beef burgers is about 20% fats. Each of these factors exhibited a significant negative effect on the quality perception of beef burger. If we replace meat in burger from vegetable there's no needed to use NO^{-}_{3} or NO_2^{-}. However, NO_3^{-} and NO_2^{-} have been reported to lead to the formation of nitrosamines which are carcinogenic in nature. So, this research was intended to develop a veggie burger using vegetable based ingredients without preservatives and investigate whether it can be used as a beef meat analogue as convenience-oriented product. In addition, the effect of binder and fat emulsion on the Veggie burger qualities stored at -18°C for 90 days was tested.

MATERIALS AND METHODS

Development of a veggie burger: This was carried with step by step trials. Initially trialed to find out suitable vegetable mixture proportion: based on sensory spinach (5.5%), bean (6.0%), capsicum (5.5%), carrot (6.0%) and mushroom (11.2%) were selected. Then preliminary trials were conducted to select vegetable form blanching of vegetables selected for further experiment based on the colour persistence followed during chill storage. Then trialed to select better legume type for burger base: chickpea was selected out of chickpea, chickpea dhal, mung bean and lentil based on maximum subjective qualities. Rice flour: Wheat flour (RW), rice flour: ISP (RI), wheat flour: ISP (WI), Chickpea flour: ISP (CI) likewise 4 binder mixtures (1:1) were tested: RW and RI were selected based on gain significantly higher mean scores followed by others.

Experimental veggie burger production: The main mixture, composed of vegetable mix (34.2%), spice mix (10.6%) and chickpea (25.2%) was processed in a chopper. The burger dough was subdivided into 4 equal portions,

Corresponding Author: P.H.G.J. De Silva, Department of Agricultural Systems, Faculty of Agriculture, University of Rajarata, Puliyankulam, Anuradhapura, Sri Lanka

to the first portion RW (25% w/w) 5E (5% w/w) and to the second portion only RW (30% w/w) was added. To the other portions RI (25% w/w) 5E (5% w/w) and RI (30% w/w) were added, respectively. Each dough was thoroughly mixed by re-chopping in the bowl chopper. About 42 g of this each mixture placed and pressed by using manual ellipse shaped mould then deep fried at 180°C for 1 min until the core temperature was around 75°C. Then product was sealed in portion of 4 and transferred to air blast freezer at -18°C.

Determination of organoleptic properties: Fifteen judges assessed the sensory properties and a 6 point hedonic scale was used. Veggie burger sample belonging different groups were examined after 1 and 90 days of storage for colour, vegetable pieces presence, texture, aroma, juiciness, oiliness, spiciness, saltiness and overall acceptability used as criteria for acceptability. According to the scoring table, scores (4-5) indicated high quality, scores (2-3) indicated moderate quality and sores (0-1) indicated the limit of unacceptability.

Determination of microbiological analysis: The experimental burger samples were analyzed for their microbial as salmonella, *Staphylococcus aureus*, *E. coli*, TPC, yeast and mould during 3 months of period in 2 weeks interval. The 10 g of sample from each package to a sterile stomacher bag with 90 mL of 2% w/w peptone water and blended for 30 sec in a stomacher. Serial decimal dilutions were prepared using the same diluents. Duplicate 0.1 or 1 mL inoculums of appropriate dilutions were spread on the followings, TPC on petirifilm™ aerobic count plate, *E. coli* on petirifilm™ *E. coli* count plate incubated at 35°C, *S. aureus* on baird parker medium, spread plates incubated at 37°C (Harrigan and McCance, 1976), yeast and mould on PDA media, pour plates incubated at 25°C. Salmonella were determined using salmonella screening device and sodium biselenite broth (Gray and Patrick, 1995).

Determination of pH: pH values of the homogenate sample were measured using a digital pH meter. Sample was homogenized with distilled-deionized water in ratio 1:1 (w/v) in stomacher.

Determination of peroxide value: Peroxide values were determined iodometric titration according to the method described by IUPAC for analysis of oils, fats and derivatives, 1989 and calculated as meq per 1 kg of fat or oil.

Determination of chemical analysis: Proximate composition as total solid, fat, organic non fat, moisture and ash was tested during the storage period (AOAC, 1984):

$$\text{Total solid content} = \frac{X3 - X1}{X2 - X1} \times 100$$

Where:

X1 = Weight of the empty thimble, filter paper and beaker
X2 = Weight of the sample, thimble, filter paper and beaker
X3 = Weight of the demoisted sample, thimble, filter paper and beaker (AOAC, 1984)

$$\text{Crude fat content} = \frac{X4 - X3}{X2 - X1} \times 100$$

Where:

X1 = Weight of the empty thimble, filter paper and beaker
X2 = Weight of the sample, thimble, filter paper and beaker
X3 = Weight of the receiving bottom flask
X4 = Weight of the receiving bottom flask with extracted fat

The moisture content of the each sample was determined by substracting the total solid content from the weight the fresh sample. The ONF content of each sample was taken by substracting the CF and total ash content from the TSC of the each sample (AOAC, 1984):

$$\text{Total ash content} = \frac{X4 - X3}{X2 - X1} \times 100$$

Where:

X1 = Weight of the empty thimble, filter paper and beaker
X2 = Weight of the sample, thimble, filter paper and beaker
X3 = Weight of the empty porcelain crucible
X4 = Weight of the empty porcelain crucible with ash

Determination of cooking loss: The weights of the veggie burgers were measured before cooking and after cooking. Then the loss of weight after cooking would be calculated.

Determination of purge loss: Three sample numbers from each sample were weighed. Then they were vacuum packed and placed in a single layer at -18°C. Purge loss was determined by reweighing blotted samples following 2 weeks of storage. Same procedure was done for each sample.

Determination of water holding capacity (AOAC, 1984):

$$\text{WHC} = \frac{B - C}{A} \times 100$$

Where:

A = Initial weight of the sample
B = Weight of the sample after centrifuging
C = Weight of the sample after oven drying

Statistical analysis: Sensory analysis was made by using non parametric Kruskal Wallis one way anova in SPSS 10.0. Objective data were analyzed by Analysis of Variance (ANOVA) in binder x emulsion x storage factorial design. Moreover, means were separated using one way anova for treatment at the same storage and storage time for individual treatment.

RESULTS AND DISCUSSION

Sensorial characters were altered with emulsion addition especially in texture and juiciness and RW5E selected as best sample based on sensory score rating remained between good and very good during storage ($p<0.05$). There were no significant differences ($p>0.05$) between colour, vegetable pieces presence and spiciness of samples during the storage but there were significant difference ($p<0.05$) between samples except vegetable pieces presence and spiciness. For all samples blanched vegetable were used. Therefore, it may be the reason for reducing colour degradation with the storage time. But samples have gained the different mean scores for colour, this may be due to the emulsion and ISP.

E. coli, *Staphylococcus aureus*, PDAC and salmonella were totally absent up to the 90 days under the frozen (-18°C) storage. So, the hygienic condition of the sample would be in satisfactory level. SLS, 1981 recommended that $>10^2$ CFU g^{-1} of mould count unsatisfactory for fried products.

Microbial load of veggie burger was lower because of the antimicrobial effects of the ingredients (i.e., spices), vegetable base used in the burger formulation, subjected to high temperature during the cooking process, prior blanching of vegetables cause destruction of microorganisms and freezing also inhibit of their growth. The approximate quantitative range of TPC is 10^3-10^7 CFU g^{-1} for the acceptability of fresh and frozen vegetable. There is no standard for veggie burger in Sri Lanka but according to hamburger standard maximum TPC was given as 10^7 CFU g^{-1} (Wehr, 1982). In 1991, SLS recommended that maximum level of TPC for precooked meat products were 10^6 CFU g^{-1}. Considering these values, TPC were satisfactory in all samples up to the 90 days of storage (Fig. 1).

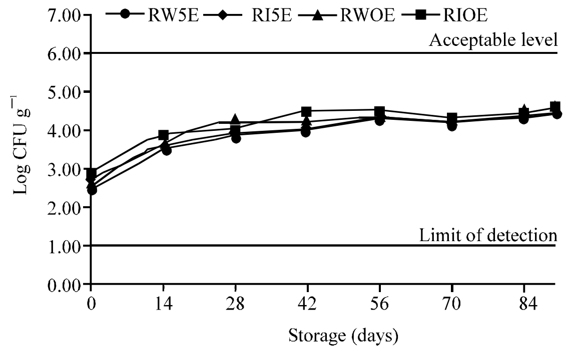

Fig. 1: Variation of TPC with storage time

Table 1: Variation of peroxide values of veggie burger with storage time

	Storage (days)			
Groups	0	30	60	90
RW5E	$7.84^{a*/w**}$	$7.96^{b/x}$	$8.88^{c/x}$	$9.62^{d/x}$
RI5E	$7.84^{a/w}$	$8.88^{b/w}$	$9.72^{c/w}$	$9.88^{d/wx}$
RWOE	$7.57^{a/x}$	$7.61^{a/z}$	$8.52^{b/z}$	$9.61^{c/x}$
RIOE	$7.55^{a/x}$	$7.83^{a/y}$	$8.63^{b/y}$	$10.22^{c/w}$

*Means in same row, **means in same column given with different letters are significantly different from the other $p<0.05$

At day 0, pH values of RW5E, RW0E, RI5E and RI0E were measured as 6.87, 6.90, 6.90 and 6.97, respectively and these values dropped orderly to the values of 6.67, 6.70, 6.70 and 6.73 at days 90. Forrest *et al*. (1975) determined that the reduction of pH during the storage could be due to the microbial activity and oxidation of fat and oils.

Statistical results showed that there were significant differences ($p<0.05$) between the samples and with the storage time for peroxide values (Table 1). They were relatively high even on the first day may be due to the oil used for fry the product was highly unsaturated and thus more susceptible to lipid oxidation. Coultate (1989) stated that peroxide value of fresh oils are <10 meq kg^{-1} when it is between 30-40 meq kg^{-1} a rancid taste can be noticeable. The data obtained in the present study suggest that peroxide values in all samples are in the good quality limits up to 90 days of storage at -18°C.

Total solid, moisture, fat and ONF were significantly change ($p<0.05$) in rice flour ISP with out emulsion than other three samples. The reduction of this moisture and fat lead to reduce the product's succulence nature. With the storage time, ash didn't significantly change ($p>0.05$) (Fig. 2). WHC was significantly reduced ($p<0.05$) within samples during the storage period (Table 2). This may be due to the changing of macro molecules during frozen storage which reduces the WHC and it leads to reduction of juiciness. The reduction of WHC, the quality of the final product can suffer because of the loss of more than the usual amount of water. Man (2002) stated that the flavour resulted due to it can be described as stale or warmed up, it was similar to that resulting from fat oxidation.

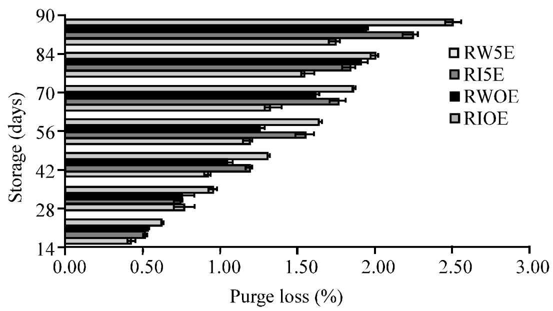

Fig. 2: Purge loss in veggie burger samples with storage

Table 2: WHC of veggie burger samples with storage time

	Storage (days)			
Groups	0	30	60	90
RW5E	$46.81^{a*/y**}$	$46.76^{a/w}$	$46.50^{b/w}$	$45.98^{c/w}$
RI5E	$47.00^{a/w}$	$46.67^{b/w}$	$46.18^{c/x}$	$45.33^{d/y}$
RWOE	$46.71^{a/z}$	$46.49^{b/x}$	$46.01^{c/y}$	$45.44^{d/x}$
RIOE	$46.97^{a/x}$	$46.27^{b/y}$	$45.82^{c/z}$	$44.81^{d/z}$

*Means in same row, ** means in same column given with different letters are significantly different from the other $p<0.05$

Purge loss was significantly differ between samples and with the storage time ($p<0.05$). WHC decline result an increase in the ability of fluid to flow (Purge). The purge loss depends on the crystallization rate formed during freezing (Drummond and Sun, 2005). After the product has been frozen, ice sublimation occurs during thawing from the product surface. If it is excessive during thawing a dry and spongy product may occurred. This may be the reason for ISP rice flour with out emulsion had dry nature. There were no any significant differences among 4 samples for cooking loss with respect to the binder or emulsion ($p>0.05$). The almost same moisture content and vegetable amount in all samples can be the reason for that.

CONCLUSION

There was a slight increment among sensory scores of veggie burger in respect to emulsion addition ($p<0.05$). According to sensory results sample which contained RW5E was selected as the best with respect to the colour, texture, aroma, juiciness, oiliness, saltiness and overall acceptability ($p<0.05$) followed by other samples during the storage period. RW addition was found to significant effective in improving the reduction of purge and WHC because of RW can have ability to avoid the development of dryness. Among the binders used RW was the best binder which can maintain the overall quality. Storage time under frozen conditions caused variation of objective qualities except ash. Development of a veggie burger using RW is shown to be an approach in processed meat analogue there by improving the nutritional value, shelf life and acceptable sensory merits. However, further studies are needed to improve the succulence nature of the rice flour wheat flour with emulsion containing sample.

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