PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF TEMPEH EXTENDED BEEF PATTIES

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Abstract – Processed meat offers the opportunity to incorporate an ingredient with a health benefit into a meat product. Soy is commonly used as an ingredient in processed meats. Tempeh is rich in nutrients and has many health benefits and could be incorporated into a beef patty. Addition of tempeh will affect the physical, chemical and sensory qualities of beef patties.

The aim of this research was to determine the changes in physicochemical properties in beef patties containing tempeh compared to controls during the display and to determine the appropriate level of tempeh that can be incorporated into beef patties.

The beef patties containing tempeh had significantly higher water and carbohydrate contents and significantly lower protein content compared to control patties. Tempeh had no effect on fat content. The incorporation of both 10% and 20% tempeh had no effect on ash content.

Tempeh containing patties were softer, less cohesive and less chewy than the control patties ($p < 0.05$). Tempeh patties had better colour stability as it maintained a lighter colour throughout storage as measured by L* values and had lower reduction in redness as measured by a* values than the control. Overall the 10% tempeh patty was the tempeh containing patty with most positive attributes.

Key Words – Colour stability, Tenderness, Texture profile

I. INTRODUCTION

Extenders are normally added to processed meat to reduce cost as well as to reduce cooking losses and improve juiciness; improve nutritional composition, for emulsification; and texture modification; increase shelf life and to improve colour stability [1].

Several extenders have been investigated for their effects on processed meat products including legume flours, sorghum, wheat, textured whey protein, whey protein concentrate and other non-flour forms of soy [2, 3, 4, 5].

Soy, in particular, is commonly used as an ingredient in processed meats. Soy has multi-functional properties such as being a stabiliser and emulsifier, ability to improve texture and water holding capacity of the final product, as well as the high nutritive value of soy protein [6]. Tempeh, a fermented soy product, is rich in nutrients and has many health benefits including many of those attributed to soy. The addition of tempeh change favourably the fatty acids profile, increase B vitamin and isoflavones contents in the product.

As meat has been suspected to be involved in likelihood of certain pathologies, particularly colorectal cancer, the antioxidants contained in tempeh may be able to limit oxidative processes during digestion, if tempeh and meat are incorporated together in a product.

Consumers have become increasingly concerned about fat consumption and have often associated red meat with high saturated fat content. The polyunsaturated: saturated (P: S) ratio and the Omega 6: Omega 3 ratio (n-6/n-3) are used as indices of the nutritional quality of food. In addition to their contribution to health, unsaturated fatty acids can oxidise easily which causes several changes in flavour, nutrition and colour [7].

Addition of tempeh to beef patties will affect their nutrient composition, colour, shelf life due to a different balance of oxidative processes and sensory properties. Consequently consumer perception of the product will be affected and it is necessary to measure the extent of these changes to determine their impact on consumers' acceptability.

The aim of this research was to examine the effects of three levels of tempeh addition (10%, 20% and 30%) on a variety of physical and chemical properties of beef patties to determine the optimum incorporation level.

II. MATERIALS AND METHODS

Samples containing no tempeh (Control), 10% w/w breadcrumb, 10% w/w tempeh, 20% w/w tempeh and 30% w/w tempeh were prepared (Table 1). Fresh samples were used for the colour stability trials and for other analyses, the patties were vacuum packed and stored at -80°C.

Table 1. Formulation of five burger patty treatments

Treatment	Lean meat %	Fat %	Tempeh %	Breadcrumb %	Salt %
Control	89	10	-	-	1
Control + 10% breadcrumb	79	10	-	10	1
Control + 10% tempeh	79	10	10	-	1
Control + 20% tempeh	69	10	20	-	1
Control + 30% tempeh	59	10	30	-	1

Proximate analysis was carried out in duplicate for three samples (individual patties) per treatment according to AOAC [8]. The fat and fatty acid methyl esters (FAME) were prepared as described by Bligh & Dyer [9].

Objective colour measurements were obtained using a HunterLab scan as described by Bekhit et al. [10]. Duplicate readings were taken on samples placed in polystyrene trays and covered with oxygen permeable polyvinylchloride film. Colour measurements were carried out at 0, 15, 24, 39, 48, 63, 72, 87 and 96 hours of retail display at 4°C.

The samples were subjected to texture profile analysis (TPA) as described by Barbut [11]. The calculated TPA parameters were; hardness, springiness, gumminess, adhesiveness, cohesiveness and chewiness.

The texture of the patties was analysed by both shear force and compression measurements. Cooked patty samples were cut into 1x 1 x 1 cm strips using a double bladed knife. Compression measurements were performed using a TA Plus texture analyser (Stable MicroSystems, Surrey, UK). Shear force measurements (hardness /tenderness) were determined using a MIRINZ tenderometer. Samples (8 bites of 1 x 1 x 1 cm) were placed in the machine and the results were obtained in Newton.

III. RESULTS AND DISCUSSION

The control patties had significantly ($p < 0.05$) lower moisture and carbohydrate content and significantly ($p < 0.05$) higher protein contents compared to patties containing tempeh. Substitution of 10 % of the meat by breadcrumbs significantly ($p < 0.05$) reduced the water and protein contents and significantly ($p < 0.05$) increased fat, carbohydrate and ash contents. Substituting the same amount of tempeh significantly ($p < 0.05$) increased water and carbohydrate contents and significantly ($p < 0.05$) decreased protein content but had no significant ($p > 0.05$) effect on fat or ash contents (Table 2).

Table 2. Proximate composition of beef burger patties, tempeh and patties with partial substitution of tempeh and breadcrumbs.

Treatment	Water	Protein	Fat	Carbohydrate	Ash
Control	68.18± 0.01d	23.38± 0.51e	6.48± 0.44a	0.00± 0.00a	1.97± 0.02b
10% breadcrumb	61.23± 0.12a	22.22± 0.16d	7.11± 0.05b	7.19± 0.01b	2.25± 0.03d
10% tempeh	68.80± 0.27c	21.71± 0.20cd	6.37± 0.30a	1.14± 0.23c	1.98± 0.16b
20% tempeh	68.30± 0.27b	21.40± 0.22c	6.51± 0.14a	1.81± 0.17d	1.99± 0.02b
30% tempeh	68.80± 0.20c	20.10± 0.21b	6.59± 0.09a	2.51± 0.07e	2.03± 0.02c
Tempeh	71.57± 0.35e	13.14± 0.31a	9.30± 0.05c	4.93± 0.08f	1.06± 0.01a

Different letters a-f denote significant ($p < 0.05$) differences between treatments. Values are the mean ± standard deviation

Substitution with tempeh or breadcrumbs significantly ($p < 0.05$) lowered the protein content of the patties (Table 2). There were no significant ($p > 0.05$) differences between 10% and 20%

tempeh, however addition of 30% tempeh caused a further reduction in protein content.

The incorporation of both 20% and 30% tempeh significantly ($p < 0.05$) increased L* values of the patties compared with the control (Figure 1). The L* values of 10% breadcrumb and control patties were not different ($p > 0.05$) with the exception at 24 and 72 hours. The control and 10% tempeh patties were not significantly ($p > 0.05$) different at 15, 48, 87 and 96 hours, but were different at all other times.

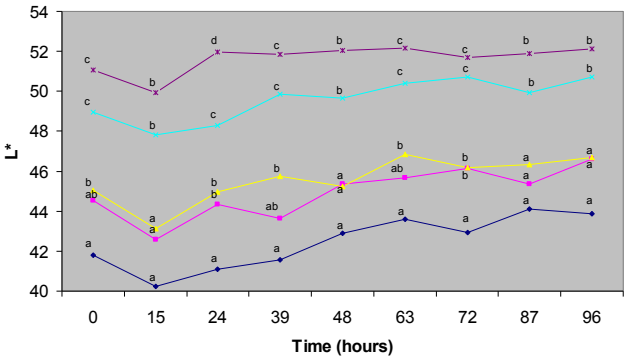

Figure 1. L* values of Control (♦), Control+10% breadcrumb (■), Control+10% tempeh (▲), Control+20% tempeh (x) and Control+30% tempeh (*) over a 96 hour storage period. Letters a-c denote significant ($p<0.05$) differences between treatments.

All a* values decreased over the 96 hours storage period reflecting a loss of the fresh red colour (Figure 2). Generally, all treatments had higher ($p < 0.05$) a* values than the control at 24, 39, 48 and 63 hours of display at 4°C. Generally, 20% and 30% tempeh patties had higher a* values compared with control patties ($p < 0.05$) but at the end of testing only 30% tempeh was significantly higher ($p < 0.05$) compared to other treatments. There were no differences ($P > 0.05$) among 10% breadcrumbs, 10% tempeh and 20% tempeh treated patties throughout the display period (Figure 2).

Yellowness (b*) values for 10% breadcrumb, 10% tempeh and 20% tempeh patties were not different ($p < 0.05$) from the control throughout storage with the exception of 10% tempeh treatment at 15 hours and 20% tempeh treatment at 24 hours (Figure 3). The 30% tempeh treatment had the highest b* values throughout storage period and was the only treatment significantly higher than the control patties.

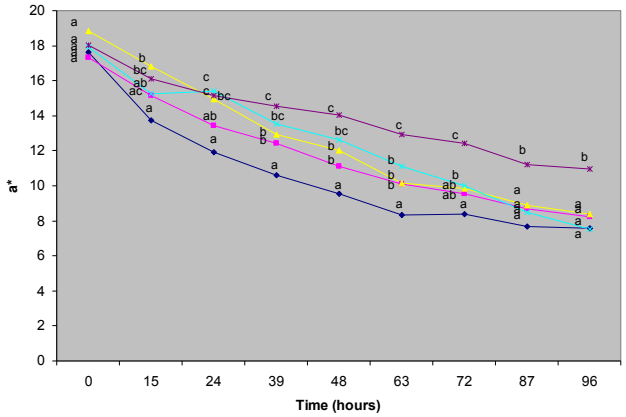

Figure 2. a* values of Control (♦), Control+10% breadcrumb (■), Control+10% tempeh (▲), Control+20% tempeh (x) and Control+30% tempeh (*) over a 96 hour storage period. Letters a-c denote significant ($p<0.05$) differences between treatments.

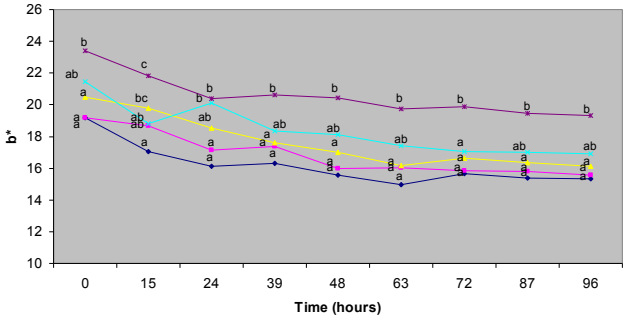

Figure 3. b* values of Control (♦), Control+10% breadcrumb (■), Control+10% tempeh (▲), Control+20% tempeh (x) and Control+30% tempeh (*) over a 96 hour storage period. Letters a-c denote significant ($p<0.05$) differences between treatments.

Sensory analysis showed that 10% tempeh containing samples to be the most preferred by consumers (data not shown) and therefore TPA was carried out on that tempeh containing samples only. The hardness of all the patties tested was varied significantly ($p < 0.05$) with the hardest were the control patties and 10% tempeh patties were the softest as measured by the compression test. The shear force as determined by the MIRINZ tenderometer was lower ($p < 0.05$) for 10% tempeh patties compared to the controls and 10% breadcrumb patties were not different from either (Table 3).

Table 3. Textural parameters of control, 10% breadcrumb and 10% tempeh cooked burger patties. Letters a-c denote significant ($p < 0.05$) differences between treatments.

Treatment	*Hard MIRINZ (N)	Hard comp (N)	Coh	Spr	Chew
Control	17.46b	85.33c	0.36c	0.75b	23.53c
Control+10% breadcrumb	16.09ab	34.43a	0.14a	0.49a	2.55a
Control+10% tempeh	13.64a	73.65b	0.31b	0.71b	16.23b

Hard MIRINZ = Hardness MIRINZ tenderometer (N);
Hard comp = Hardness Compression (N);
Coh = Cohesiveness;
Spri = Springiness;
Chew = Chewiness.

Addition of 10% tempeh had no significant effect on the springiness of patties. Addition of 10% tempeh significantly ($p < 0.05$) decreased the cohesiveness. Chewiness was significantly ($p < 0.05$) decreased by addition of 10% tempeh (Table 3).

IV. CONCLUSION

Addition of tempeh to beef patties produced a variety of physical and chemical quality changes. The beef patties containing tempeh had significantly higher water and carbohydrate contents and significantly lower protein content compared to control patties. Incorporation of tempeh was not detrimental to the nutritional profile of the beef patties although protein content was slightly decreased.

Overall, the 10% tempeh patty was the tempeh containing patty with most positive attributes. Adding 10% tempeh did not diminish the nutritive value of the patty. This patty maintained better colour stability compared to the control and had values of L*, a*, b*, which are considered more appealing throughout storage. The incorporation of tempeh in beef patties can be very successful in improving the nutritional and the keeping qualities of this product.

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