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Chemical Composition and Sensory Quality of Tofu Prepared From Sudanese Soymilk

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Abstract: *Soymilk and tofu are nutritional soy-based foods with strong evidence to suggest their positive impact on health. Soymilk production is relatively simple and requires only a few steps, as well as tofu production. Both of these foods utilize the whole bean and provide an efficient means of converting raw soybeans into edible products. Four samples of soft cheese-like product were prepared from soymilk using four levels of sweet whey powder. The prepared tofu samples were stored at 10±2ºC and the analyses were carried out. The chemical composition of tofu samples with the addition of 0, 5, 10 and 15% sweet whey powder were 54.37%, 49.40%, 44.40%and 39.34%for moisture content; protein content 18.66%, 20.46%, 22.26%, and 23.06%; fat content 6.90%, 8.30%, 8.50% and 9.50%; ash content 7.47%, 7.92%, 8.37% and 8.82%, respectively (P≤0.05). The levels of sweet whey powder significantly (P≤0.05) affected the pH-value of tofu. Cheese sample prepared with15% sweet whey powder was the lowest (5.21) while that prepared with 0% sweet whey powder the highest (5.46). The levels of sweet whey powder significantly (P≤0.05) affected the titratable acidity of tofu. Cheese sample prepared with 15% sweet whey powder was the highest (0.90%), while cheese sample prepared with 0% sweet whey powder was the lowest (0.56%). The best score of appearance, texture, flavour and overall acceptability was obtained by cheese sample with 10% sweet whey powder, compared to other samples.*

Keywords: Soymilk; Tofu; Physicochemical; properties; Sensory evaluation

Introduction

The soybean (*Glycine max*) is one of the most important food plants of the world, and seems to be growing in importance. It is an annual crop, fairly easy to grow, that produces more protein and oil per unit of land than nutrients.Soybeans are composed of approximately 37% protein, 18% oil, 15% soluble carbohydrate, 15% insoluble carbohydrate and 14% moisture [1]. Soybean is a recently introduced crop in Sudan by UNIDO. It can contribute cash crop for farmers an enables introduction of local processing to add value to the raw product. Therefore, soybean production and processing is expected to increase income of farmers and create new jobs especially for the youth. UNIDO supported the Ministry of Industry of Sudan with 2 phase-projects on soybean production and processing (machines of soymilk processing). The project is implemented in Gezira and Sinnar States. The target groups are small holder farmers in Gezira and Rahad schemes in the Gezira State and Suki schemes in Sinnar State[2].

Soymilk is a water extract of whole soybeans. It is an off-white emulsion containing the water soluble proteins and carbohydrates and most of the oil of soybean [3]. Due to the high cost of milk in Sudan, which ultimately increases the cost of milk products, other alternatives are currently being sought of in order to process nutritionally acceptable fermented dairy products, such as soymilk.Cheese in Sudan it is known when white soft cheese was first introduced into the Sudan but it is most likely the Sudan has recognized this type of cheese for nearly a century [4]. The dairy product, in Sudan include rob, gariss, biruni, mish, yoghurt and white and braided cheese (GibnaMudaffara). According to [5], the cheese in the Sudan can be classified into white soft cheese (Gibnabaida) semi-soft (Mozzarella cheese and Mudaffara) and hard cheese (Romia).

Tofu is an unfermented soy product, also known as soy bean curd and is a soft, cheese-like food made by curdling fresh hot soy milk with a coagulant which is either a salt ($CaCl_2$, $CaSO_4$) or an acid (glucuno-d-lactone). Traditionally the curdling agent used to make Tofu is nigari-a compound found in natural ocean waters or Calcium Sulfate ($CaSO_4$) [6].The objectives of this work are to prepare the milk from soyseed and prepare modified soft cheese-like product with lime juice as affected by levels of sweet whey powder.

Material and methods

- Soybean seeds from Kenana company, Khartoum, Sudan.
- Sweet whey powder, lime, salt and package from local market, Khartoum, Sudan.

Preparation of soybean milk

Preparation of soymilk was done using the method described [7]with modifications. 200 g dry, mature, whole soybeans are soaked in 3L water (0.5 $NaHco_3$) at 25°C for 18 h. The soaked bean drained and blanched for 25 minutes at 100°C, ground in a pulp using

an electric blender with addition of 1:3 water. The resulting suspension is filtered through 3 layer of cheesecloth, autoclaved 15 min at 121°C.

Preparation of whey powder

According to the method described by [8]sample of sweet whey powder was clarified, and then heated to 72ºC for 1min. concentrated by rotary evaporator at low heat temperature less than 100ºC to 50%. The concentrated whey was transferred to spray dyer (An hydro Type Lab S1) and dried at 180ºC at pressure 1.5 bar and flow rate 20ml/minutes. The composition of whey powder shown that 97.61% for total soild 12.53% for protein, 75.20% for lactose, 0.60% for fat and 9.32% for ash.

Preparation of tofu

According to [9] modified. The temperature of soymilk was lowered to 75°C. Then sweet whey powder (0, 5, 10 and 15%) was added. The coagulating agents (150ml) were added with continuous stirring. The concentration of the salts used was 2% and the titratable acidity of lemon juice was 5.0%. The resultant curd was transferred to a home-made mould (20.3 x 20.3 x 18.4 cm3) lined with muslin cloth, 2% salt were added and pressed for 3 h by placing a weight of 8 kilograms' soya cheese samples were weighed and the produced cheese stored at 10±2°C for analysis.

Physicochemical Analysis

The moisture, protein, fat and ash contents were carried out according to [10].

Sensory evaluation

The sensory evaluation was performed by 10 untrained panelists using scoring procedure according to [11].

Statistical analysis

Were performed using the Statistical package for Social (SPSS). Mean ± SD. were tested using One Factor Analysis of Variance (ONE-WAY ANOVA), and then means separated using Duncan's Multiple Range Test [12].

Result and Discussion

Chemical composition of soybean seeds

The moisture, oil, protein, ash and fiber contents of soybean seed samples (S1, S2, and Mixed) were found to be (4.55%, 4.77%, and 4.60%), (15.55%,17.55%and 16.50%), (41.13%, 41.13%, and 41.13%), (5.17%, 5.07% and 5.10%) and (6.93%, 6.95% and 6.94%) respectively (Table 1.). These values are in conformation with [13] and [14]. [15] concluded that, the environmental factors such as precipitation and temperature can affect the composition of soybean seeds.

Physicochemical composition of soybean milk

The physicochemical composition of soybean milk samples (S1, S2 and Mixed) show total solids ranged from 7.10% to 7.69%, protein ranged from 3.12% to 3.15%,oil ranged from 1.80% to 2.00%, carbohydrate ranged from 1.18% to 2.36%, ash ranged from 0.50% to 0.82%, 0.05% fiber from 0.05% to 0.15%, titratable acidity from 0.18% to 0.24% and pH value ranged from 6.50 to 6.55, this agrees with that findings of [16],[17],[18] and [19].

Table 1: Proximate composition of soybean seeds

Parameter%	Soybean seed samples		
	Sudan 1	Sudan 2	Mixed
Moisture	4.55^{b} ± 0.09	4.77^{a} ± 0.13	4.60^{ab} ± 0.17
Oil	15.55^{c} ± 2.41	17.55^{a} ±3.13	16.50^{b} ± 3.52
Protein	41.13^{a} ± 5.06	41.13^{a} ± 5.06	41.13^{a} ± 5.06

Ash	$5.17^{a} \pm 0.21$	$5.07^{b} \pm 0.18$	$5.10^{ab} \pm 0.23$
Fiber	$6.93^{a} \pm 0.25$	$6.95^{a} \pm 0.27$	$6.94^{a} \pm 0.33$

Mean value(s) ±SD. having different superscript(s) in rows are significantly different (P≤0.05).

Table 2: Physicochemical properties of soymilk samples

Parameter	Soybean milk samples		
	Sudan 1	Sudan 2	Mixed
Total solids(%)	$7.69^{a} \pm 0.55$	$7.10^{b} \pm 0.51$	$7.50^{ab} \pm 0.53$
Protein content (%)	$3.15^{a} \pm 0.08$	$3.12^{a} \pm 0.06$	$3.13^{a} \pm 0.11$
Fat content (%)	$1.80^{a} \pm 0.05$	$2.00^{a} \pm 0.07$	$1.90^{a} \pm 0.06$
Carbohydrate content (%)	$2.36^{a} \pm 0.17$	$1.18^{b} \pm 0.12$	$2.00^{ab} \pm 0.07$
Ash content(%)	$0.82^{a} \pm 0.03$	$0.50^{a} \pm 0.02$	$0.60^{a} \pm 0.01$
Fiber content (%)	$0.05^{a} \pm 0.00$	$0.15^{a} \pm 0.00$	$0.10^{a} \pm 0.00$
Titratable acidity (%)	$0.24^{a} \pm 0.00$	$0.18^{a} \pm 0.00$	$0.20^{a} \pm 0.00$
pH value	$6.50^{a} \pm 0.47$	$6.55^{a} \pm 0.49$	$6.52^{a} \pm 0.41$

Mean value(s) ±SD. having different superscript(s) in rows are significantly different (P≤0.05).

Physicochemical properties of tofu

Chemical properties of tofu

The chemical properties of tofu were significantly (P≤0.05) affected by the levels of sweet whey powder as shown on Table 3. tofu sample made with 15% sweet whey powder recorded the highest content of total solids, protein, fat, carbohydrate, ash and fiber content compared with the control sample (0% sweet whey powder) that gave the lowest. The other samples show an intermediate position (P≤0.05) of chemical composition. The increase of sweet whey powder increased the chemical properties of tofu. Total solids of tofu sample ranged from 45.63% to 60.66%, this agrees with that findings of [20], [21], and [22]. And these values of total solids of tofu disagrees with that findings of [23], [24], [25], [26], [27], [28] and [9]. Protein content of prepared tofu samples ranged from 18.66% to 23.06%, these values are comparable to [29], [22], and [27], the results of protein for prepared tofu samples was higher than that reported by [23], [24], [25], [30], [26], [9] and [31] and it depends on processing condition and soybean variety used. fat content of prepared tofu sample ranged from 6.90% to 9.50%, these results was similar to that reported by [30], [27], [22], and [26]. On the other hand, the result of fat content of prepared tofu samples was higher than that reported by [23], [24], [25], and [9]. Carbohydrates content of prepared tofu samples ranged from 12.58% to 19.28%, these value agreements with finding of [30], [24], [22], and [9]. And disagree with those of reported by [23] and [26]. Ash content of prepared tofu samples ranged from 7.47% to 8.82%, these results disagrees with findings of [23], [24], [30], [26] and [9]. Soybean varieties influenced the quality of soybean and soymilk and also affected the functional properties of soycheese , and coagulant type and preparation methods [31].

Titratable acidity

The levels of sweet whey powder significantly (P≤0.05) affected the titratable acidity of the cheese Table 3 . 15% sweet whey powder was the highest (0.90%), while 0% sweet whey powder was the lowest (0.56%).[20] reported that, the titratable acidity of low fat locally processed cheese increased with increasing the amount of denatured whey protein.

pH-value

The levels of sweet whey powder significantly (P≤0.05) affected the pH-value of tofu Table. 3 . Cheese Sample made with 15% sweet whey powder was the lowest (5.21) and sample made with 0% sweet whey powder was the highest (5.46), these values was fall within the range reported by [28], while these results was higher than that reported by [31], and lower than that reported by [32] and [33].

Table 3: Physicochemical properties of tofu

Parameter	Levels of sweet whey powder (%)			
	0	**5**	**10**	**15**
Total solids (%)	45.63^{d} ±0.27	50.60^{c} ±0.34	55.60^{b} ±0.41	60.66^{a} ±0.48
Crude protein (%)	18.66^{d} ±0.14	20.46^{c} ±0.18	22.26^{b} ±0.21	23.06^{a} ±0.25
Fat content (%)	6.90^{c} ±0.04	8.30^{b} ±0.05	8.50^{b} ±0.09	9.50^{a} ±0.11
Carbohydrates (%)	12.58^{d} ±0.07	13.92^{c} ±0.10	16.47^{b} ±0.13	19.28^{a} ±0.16
Ash content (%)	7.47^{d} ±0.01	7.92^{c} ±0.02	8.37^{b} ±0.04	8.82^{a} ±0.09
Titratable acidity (%)	0.56^{d} ±0.00	0.68^{c} ±0.00	0.79^{b} ±0.01	0.90^{a} ±0.02
pH-value	5.46^{a} ±0.08	5.38^{ab} ±0.06	5.29^{bc} ±0.03	5.21^{c} ±0.02

Mean value(s)±SD. having different superscript(s) in rows are significantly different (P≤0.05).

Sensory attribute of tofu

The sensory quality attributes (appearance, flavor, taste and overall acceptability) of tofu was found to be affected by the level of sweet whey powder Table 4. It was found that, the sensory quality of tofu samples was good as indicated from the sensory score data. The overall comparative of cheese made with 10% sweet whey powder were found optimum and acceptable compared to other samples(P≤0.05).

Table 4:Sensory attribute of tofu

Quality attributes	Levels of sweet whey powder (%)			
	0	5	10	15
	Scores			
Appearance	3.75^{b} ±0.04	3.86^{ab} ±0.03	4.08^{a} ±0.11	3.97^{a} ±0.7
Texture	3.92^{b} ±0.06	4.04^{ab} ±0.09	4.28^{a} ±0.17	4.16^{a} ±0.13
Flavour	3.90^{c} ±0.05	4.20^{b} ±0.15	4.44^{a} ±0.21	4.32^{ab} ±0.18
Overall acceptability	3.86^{b} ±0.03	4.03^{ab} ±0.8	4.27^{a} ±0.19	4.15^{a} ±0.14

Mean value(s)±SD. having different superscript(s) in rows are significantly different (P≤0.05).

Conclusion

Finley, the cost of cheese preparation is reduced because of the cheaper price of lemon extract than that of commercial salts. In this way, it was concluded that the extract of Lemon Juice coagulants could be used as a natural coagulant in coagulation processes of soymilk and thus utilization of soymilk has a positive impact not only on the consumers' health, but also reducing the costs of raw materials, and thus lowering production costs.

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