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Sustainable Tofu Production Using Lime Juice and Tamarind Extract: Natural, Low-Carbon Alternatives to Synthetic Coagulant

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Conventional tofu production often relies on synthetic coagulants, which may involve energy-intensive manufacturing and limited sustainability. This study investigates using natural acid coagulants, lime juice and tamarind extract, as environmentally friendly alternatives for soy milk coagulation. Coagulation was conducted at pH levels of 4.6, 4.8, 5.0, and 5.2, using souring solutions pre-adjusted to pH 2.0, 2.2, and 2.4. The highest protein curd yield was obtained with coagulation solutions at pH 2.2. Tofu samples coagulated at pH 5.0 exhibited the most favourable characteristics, including desirable colour parameters (L*, a*, b*), texture profile, water-holding capacity, and uniform microstructure as observed by scanning electron microscopy. Lime juice consistently produces tofu with better texture and moisture retention than tamarind extract. These findings highlight the potential of using natural plant-derived acids instead of synthetic agents such as glucono delta-lactone and sodium acetate. Using minimally processed, locally available ingredients aligns with sustainable food system goals and contributes to scalable, low-carbon innovations in plant-based protein production.

1. Introduction

Tofu is a traditional soy-based food product highly valued for its rich content of vegetable protein, essential amino acids, lipids, minerals, and bioactive compounds such as isoflavones. It is favoured globally by vegetarians and those on low-fat diets due to potential health benefits, such as reducing cardiovascular risks and metabolic disorders(Shangxin et al., 2016).

In Vietnam, tofu is widely consumed and primarily produced in traditional, artisanal settings. Despite its nutritional value and popularity, the tofu industry still faces significant challenges related to food safety and quality control. The most critical step in tofu production is coagulation, where the formation and stability of the protein gel network determine both the texture and the yield of the final product (Cao et al., 2017). However, traditional Vietnamese tofu producers often rely on low-cost chemical coagulants such as gypsum ($CaSO_4$), alum ($KAl(SO_4)_2 \cdot 12H_2O$), or even hazardous substances like borax and formaldehyde, posing serious risks to consumer health (Nguyet and Ngoc, 2014). These substances, especially when used without purification or proper dosage control, can leave harmful residues, including heavy metals or irritants, in the final product. Moreover, although coagulants like Glucono Delta-Lactone (GDL) offer safe and reproducible results (Guan et al., 2021), they are often unaffordable or inaccessible for local producers in rural areas (Fasoyiro, 2014).

Given the increasing demand for clean-label (Galanakis, 2022), additive-free foods and organic tofu in both domestic and export markets, there is an urgent need to develop natural, safe, and cost-effective alternatives to synthetic coagulants. Citrus fruits such as lime (*Citrus latifolia*) and tamarind (*Tamarindus indica* L.) are abundant in Vietnam and have traditionally been used as acidulants in food. They contain organic acids (citric, tartaric, and ascorbic acids), polyphenols, and minerals, which can effectively lower pH to the isoelectric point of soy protein and trigger protein aggregation (Guan et al., 2021). These agents offer a dual advantage:

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improved food safety and alignment with modern trends toward sustainable and natural food processing (FAO and Nations, 2018).

Despite their availability, few systematic studies have compared the effectiveness of lime juice and tamarind extract as natural coagulants for tofu production, particularly in terms of gel strength, microstructure, water retention, and sensory attributes. Therefore, this study aimed to investigate the impact of lemon juice and tamarind extract on the physicochemical properties of tofu, with a focus on identifying optimal coagulation pH for desirable gel formation. The findings are expected to contribute toward cleaner, safer, and more sustainable tofu processing technologies applicable at both household and semi-industrial scales.

2. Materials and Methods

2.1 Materials

Fruits of Seedless Lemon (*Citrus latifolia*) grown in Hau Giang Province, Vietnam, Soybean (*Glycine max* (L.) Merr), Tamarind (*Tamarindus indica* L.) are agricultural products of Vietnam, meeting food-grade standards, Control Sample (CS): Ta Tofu, a product of Vi Nguyen Co., Ltd product is packaged in 280 g units, with the ingredients on the packaging: soy protein, water, mono and diglyceride fatty acid, calcium sulfate, magie chloride, calcium propionate, salt.

2.2 Steps for Preparation

The tofu was prepared based on the modified method of Sanjay et al. (2008), with the detailed preparation steps described below:

Step 1 – Preparation of Soymilk: One hundred grams of cleaned soybeans were soaked in 500 mL of water for 8 h at room temperature. The soaked beans were ground with water at a ratio of 1:9 (w/w) using a NewSun DM-Z80A soymilk grinder. The resulting slurry was filtered through a muslin cloth to obtain raw soymilk. The average volume recovered per batch was 916.67 ± 4.16 mL, with an initial pH of 6.26 ± 0.04.

Step 2 – Coagulant Preparation: Lemon solution: 20 mL of lemon juice (pH 1.82 ± 0.07) was diluted with 116 ± 7 mL of distilled water to obtain a solution with pH 2.21 ± 0.02. Tamarind solution: 50 g of tamarind pulp (with seeds) was soaked in 100 mL of water at 70 ± 5°C for 15 min and filtered to obtain 96 ± 1.5 mL extract (pH 1.92 ± 0.04). This was diluted with 124 ± 4.6 mL of water to adjust pH to 2.21 ± 0.03.

Step 3 – Tofu Production: A total of 700 mL of soymilk was heated to 100°C. Approximately 50% of the coagulant was added, followed by gentle stirring for 10 min. The remaining coagulant was then added, and the mixture was heated again to 100°C and held for another 10 min. The curd was transferred into a cloth-lined mould and pressed with a 0.5 kg weight (0.09 N/cm²) for 70 min. Formed tofu was cooled in water at 27 ± 2°C for 10 min, drained, and stored at 5 ± 1°C prior to analysis.

2.3 Determination of Tofu Yield

Tofu production efficiency was evaluated by comparing the mass of fresh tofu obtained with the initial soybean mass used in the process, following ISO 712:2009 standard – Cereals and cereal products – Determination of moisture content – Routine reference method (Standardization, 2009). Upon completion of the coagulation and pressing stages, the fresh tofu was weighed using a precision electronic balance (±0.01 g). The weight of dry soybeans used prior to soaking and processing was recorded accurately. The tofu yield was calculated using the following Eq(1):

$$\text{Tofu Yield (TY,\%)} = \frac{Mass\ of\ fresh\ tofu\ (g)}{Mass\ of\ dry\ soybeans\ (g)} \times 100 \quad (1)$$

2.4 Method for determining the water-holding capacity of tofu

The WHC of tofu samples was determined according to the method of Teng et al. (2015) with some modifications. Each sample was cut into 10g of tofu and centrifuged at 7000 rpm for 15 min, then the water mass was released. Measurements were triplicated. WHC was calculated according to the formula as Eq(2):

$$\text{WHC (\%)} = \frac{A-B}{A} \times 100 \quad (2)$$

where B is the weight (g) of water lost from the tofu during centrifugation and A is the initial weight (g) of the samples. Each measurement was performed in triplicates.

2.5 Determination of the Texture of Tofu

A texture analyzer (Brookfield FM3 4500, USA) equipped with a TA11/1000 cylindrical probe was used to compress tofu cubes (2 × 2 × 2 cm) at a depth of 5 mm, speed of 2 mm/s, and a 0.5 N load sensor. Texture parameters evaluated included hardness, toughness, elasticity, plasticity, and cohesiveness.

2.6 Determination of the Colour Parameters

The colour parameters of tofu were determined according to the method of Dang et al. (2023) with some modifications. A colourimeter (Croma Meter CR-410, Minolta Co., Ltd., Osaka, Japan) served in the assessment of tofu colour after removing the mould and storing it for 12 h. Prior to measurement, the instrument underwent calibration at ambient conditions in accordance with the manufacturer's guidelines, utilizing the supplied white calibration plate. The calibration was based on standard values (Y, x and y: 83.7, 0.3199 and 0.3266 or L*a*b*: 93.32, 4.74 and 0.375).
The whiteness index (WI) was calculated according to the Eq(3):

$$WI = 100-\sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}} \quad (3)$$

2.7 Sensory Evaluation of Tofu

Flash Descriptive Analysis (FDA), combined with a 5-point intensity rating scale, was conducted to characterize the sensory attributes of tofu samples. Three tofu variants were assessed: samples coagulated with lime juice, tamarind extract, and the CS according to Obatolu (2008), with modifications. A panel of nine trained assessors participated in the evaluation. Before testing, the panel underwent a consensus session to develop and standardize a list of sensory descriptors relevant to external tofu attributes, including colour, odour, and texture. Fresh tofu samples were prepared on the day of testing, cut into cubes (2 × 2 × 2 cm), and presented on plastic plates with random three-digit codes to minimize bias. Each attribute was rated using a 5-point intensity scale (1 = very weak, 5 = very strong), rather than traditional ranking, allowing for more detailed statistical comparisons between samples. All evaluations were conducted under standardized conditions, and the collected sensory data were analyzed using Analysis of Variance (ANOVA) and Principal Component Analysis (PCA) to determine statistically significant differences among the samples.

2.8 Statistical Analysis

Each experiment was conducted three times, and the data were analyzed using Statgraphics Centurion XV and Excel software. A p-value < 0.05 was considered statistically significant. All data are presented as mean ± standard deviation (SD).

3. Results and Discussions

3.1 Tofu yield and the water holding capacity of tofu

Table 1 presents the tofu yield (TY, %) achieved using different pH levels of coagulants, including leme juice and tamarind extract.

Table 1: Tofu yield (TY, %) at different pH levels of coagulant

pH	2.0	2.2	2.4
Lime juice (%)	175.33^{y} ± 1.53	178.33^{y} ± 2.08	167.33^{x} ± 1.53
Tamarind extract (%)	164.00^{x} ± 1.73	177.00^{y} ± 1.73	161.00^{x} ± 3.61

The table shows mean values ± standard deviation, different letters x, y indicate differences in rows with statistical significance P-value < 0.05.

At pH 2.2, both lemon juice and tamarind extract yielded the highest curd weights, 178.33 ± 2.08 g and 177.00 ± 1.73 g, respectively. Across all tested pH levels (2.0, 2.2, and 2.4), lemon consistently produced higher yields than tamarind, likely due to the stronger acidity of citric acid compared to tartaric acid. This finding aligns with the results reported by Sanjay et al. (2008), who recorded curd yields of 21.5 ± 0.81 g/100 mL for *Citrus lemon* and 21.0 ± 0.72 g/100 mL for *Tamarindus indica*.
At pH 2.0, the reduced yield may result from overly rapid coagulation that hinders proper protein-protein interaction and gel formation. At pH 2.4, the lower acid strength limits the protonation of amino groups, leading to incomplete aggregation. This limitation is particularly pronounced in tamarind extract, where tartaric acid (a diprotic acid) induces slower acidification and forms a weaker gel. In contrast, citric acid, with three carboxyl groups, facilitates more effective coagulation through stronger acidifying capacity and faster gelation kinetics. These mechanisms, also explain why excessive or insufficient acid strength impairs network formation and yield (Cao et al., 2017).
Furthermore, the water-holding capacity (WHC) data in Table 2 corroborates this trend. Tofu prepared with lemon juice reached the highest WHC (90.33 ± 1.53 %) at pH 4.8, whereas tofu from tamarind extract peaked at only 79.00 ± 1.73 % at pH 4.6. These differences can be attributed to the coagulants' acidification dynamics, degree of protonation, and impact on gel network formation (Cao et al., 2017).

Table 2: Water holding capacity (WHC) of soymilk at different pH levels adjusted using lemon juice and tamarind extract

pH	4,6	4,8	5,0	5,2	CS
Lime juice (%)	$87.00^{by} \pm 1.73$	$90.33^{cy} \pm 1.53$	$75.33^{ax} \pm 1.53$	-	$76.67^{a} \pm 1.15$
Tamarind extract (%)	$79.00^{cx} \pm 1.73$	$70.67^{ax} \pm 2.89$	$70.67^{ax} \pm 2.52$	$75.00^{b} \pm 1.73$	

The table shows the mean values ± standard deviation, different letters a, b, c, and d indicate differences in rows, and letters x, and y indicate differences in columns with statistical significance P-value < 0.05. Note: (-) The ability to form curd during the same survey period was very weak, so almost no tofu could be recovered.

Higher WHC in lemon tofu reduced pigment retention, producing a brighter gel, while lower WHC in tamarind tofu increased lipid content, enhancing carotenoid solubilization and yellow colour (Duc et al., 2021). These effects result from interactions between coagulant type, protein solubility, and WHC during gel formation (Hendrawati et al., 2021). Similar findings were reported by da Silva Scherer et al. (2023), who observed yellowing in tofu made with cardoon flower extract due to natural pigments. Similar findings were reported by da Silva Scherer et al. (2023) regarding other natural coagulants, who observed yellowing in tofu made with cardoon flower extract due to natural pigments.

3.2 Structure, colour, and surface morphology of tofu at different coagulation concentrations

Hardness, defined as the force required for deformation (Obatolu, 2008), decreased with lower coagulation pH in both lemon- and tamarind-induced tofu, consistent with findings by Cao et al. (2017). Table 3 shows that the hardness and gumminess of tofu increased significantly as the pH rose from 4.6 to 5.0 for both lime juice and tamarind extract as coagulants. At pH 4.6 and 4.8, lemon-coagulated tofu exhibited slightly better hardness and elasticity than tamarind, but at pH 5.0, both coagulants produced tofu with markedly firmer and chewier textures, especially lime juice, which resulted in the highest gumminess (26.04 ± 0.31 mJ), even surpassing the CS (23.98 ± 2.41 mJ) (α = 0.05). Cohesiveness peaked at pH 5.0 with values of 0.48 ± 0.00 (lemon) and 0.40 ± 0.02 (tamarind), indicating stronger internal bonding, while elasticity, defined as the ability to return to its original shape after compression (Liu et al., 2013), also reached maximum values of 7.19 ± 0.08 mm and 7.56 ± 0.21 mm, respectively. However, at pH 5.2, lime juice failed to induce coagulation, whereas tamarind extract still formed tofu with acceptable texture (hardness 7.78 ± 0.61 N). Overall, textural properties improved from pH 4.6 to 5.0 and declined thereafter. Tamarind extract showed more consistent performance across pH levels, while lime juice was more effective at lower pH but lost its coagulation ability at higher pH. The optimal structural integrity was observed at pH 5.0, comparable to that of GDL-induced tofu (α = 0.05).

Table 3: Texture of tofu with lemon coagulant and tamarind coagulant

pH	4.6	4.8	5.0	5.2	CS
Lime juice (%)					
Hardness (N)	$5.24^{ax} \pm 0.34$	$4.84^{ax} \pm 0.48$	$7.53^{bx} \pm 0.06$	-	$7.19^{b} \pm 1.05$
Cohesiveness	$0.32^{ax} \pm 0.02$	$0.33^{ax} \pm 0.04$	$0.48^{by} \pm 0.00$	-	$0.47^{b} \pm 0.03$
Springiness (mm)	$6.96^{ax} \pm 0.34$	$7.62^{by} \pm 0.14$	$7.19^{ax} \pm 0.08$	-	$7.08^{a} \pm 0.11$
Gumminess (mJ)	$11.69^{ax} \pm 0.60$	$12.15^{ay} \pm 0.05$	$26.04^{by} \pm 0.31$	-	$23.98^{b} \pm 2.41$
Tamarind extract (%)					
Hardness (N)	$5.35^{ax} \pm 0.20$	$5.35^{ax} \pm 0.18$	$7.30^{bx} \pm 0.21$	$7.78^{b} \pm 0.61$	$7.19^{b} \pm 1.05$
Cohesiveness	$0.36^{ax} \pm 0.03$	$0.34^{ax} \pm 0.02$	$0.40^{bx} \pm 0.02$	$0.33^{a} \pm 0.01$	$0.47^{c} \pm 0.03$
Springiness (mm)	$6.34^{bx} \pm 0.50$	$5.28^{ax} \pm 0.18$	$7.56^{cy} \pm 0.21$	$5.68^{a} \pm 0.31$	$7.08^{c} \pm 0.11$
Gumminess (mJ)	$12.11^{bx} \pm 0.51$	$9.72^{ax} \pm 0.56$	$22.18^{dx} \pm 0.36$	$14.49^{c} \pm 1.22$	$23.98^{d} \pm 2.41$

The table shows the mean values ± standard deviation, different letters a, b, c, and d indicate differences in rows, and letters x, and y indicate differences in columns with statistical significance P-value < 0.05. Note: (-) The ability to form curd during the same survey period was very weak, so almost no tofu could be recovered.

Colour changes due to pH are shown in Table 4. For lemon juice, increasing pH from 4.6 to 5.0 reduced L* (89.31 → 85.88) and whiteness index (WI: 82.89 → 78.66), while b* increased (12.37 → 15.97), indicating yellowing. However, at pH 5.0, WI was not significantly different (α = 0.05) between lemon-, tamarind-, and GDL-coagulated tofu (GDL: 79.74 ± 5.11). Tamarind tofu showed rising L* and WI from pH 4.6 to 5.0 (L*: 84.24 → 88.83; WI: 77.88 → 80.80), then declined slightly at pH 5.2. Tamarind samples had higher b* values than lemon ones, likely due to natural pigments in tamarind, which darken over time through enzymatic and non-enzymatic browning (Obulesu and Bhattacharya, 2011).

Table 4: Colour of tofu with lemon coagulant and tamarind coagulant

pH	4.6	4.8	5.0	5.2	CS
Lime juice (%)					
L*	$89.31^{cy} \pm 0.46$	$87.15^{by} \pm 0.01$	$85.88^{ax} \pm 0.47$	-	$85.72^{a} \pm 0.09$
a*	$5.03^{cy} \pm 0.06$	$0.73^{bx} \pm 0.13$	$0.82^{bx} \pm 0.07$	-	$0.49^{a} \pm 0.06$
b*	$12.37^{ax} \pm 0.25$	$14.56^{ax} \pm 0.43$	$15.97^{ax} \pm 0.09$	-	$18.32^{d} \pm 0.45$
WI	$82.89^{ay} \pm 0.47$	$80.57^{ay} \pm 0.33$	$78.66^{ax} \pm 0.38$	-	$79.74^{a} \pm 5.11$
Tamarind extract (%)					
L*	$84.24^{ax} \pm 0.19$	$84.51^{ax} \pm 0.99$	$88.83^{bx} \pm 1.59$	$85.66^{a} \pm 0.08$	$85.72^{a} \pm 0.09$
a*	$2.24^{dy} \pm 0.16$	$1.46^{cy} \pm 0.32$	$1.03^{bx} \pm 0.14$	$0.87^{b} \pm 0.27$	$0.49^{a} \pm 0.06$
b*	$15.36^{ay} \pm 0.29$	$15.35^{ax} \pm 0.87$	$15.54^{ax} \pm 0.95$	$15.34^{a} \pm 0.38$	$18.32^{d} \pm 0.45$
WI	$77.88^{ax} \pm 0.28$	$78.07^{ax} \pm 1.14$	$80.80^{ay} \pm 1.14$	$78.98^{a} \pm 0.32$	$79.74^{a} \pm 5.11$

The table shows the mean values ± standard deviation, different letters a, b, c, and d indicate differences in rows, and letters x, and y indicate differences in columns with statistical significance P-value < 0.05. Note: (-) The ability to form curd during the same survey period was very weak, so almost no tofu could be recovered.

These physicochemical changes were reflected in microstructure (Teng et al., 2015). SEM images revealed honeycomb-like protein matrices with varied pore sizes. Lemon-coagulated tofu (Figure 1a) showed a dense, rough gel with small crystalline protein clusters, enhancing water retention and hardness (Zheng et al., 2020), likely due to the rapid, tight protein aggregation from high acidity.

The tofu sample coagulated with tamarind extract (Figure 1b) had a smoother surface, fewer protein clusters, and smaller dispersed crystals, resulting in a softer, less stable gel. This may stem from differences in acid composition and acidification rates, leading to slower protein coagulation and a weaker gel network. In contrast, GDL-coagulated tofu (Figure 1c) showed a smooth, uniform structure with fine crystals, due to the gradual hydrolysis of GDL into gluconic acid, which allows slow pH reduction and controlled gel formation ideal for consistent industrial tofu production. These SEM observations confirm that different acids influence the microstructure of tofu gels depending on their molecular properties: citric acid (from lemon juice), with its three –COOH groups, facilitates rapid pH adjustment and strong protein coagulation, while tartaric acid (from tamarind), although having higher affinity for metal ions, possesses fewer carboxylic groups, thus forming weaker gels due to slower acidification and gelation rates (Cao et al., 2017). Besides optimizing coagulation and microstructure, tofu sustainability also involves valorizing soymilk by-products. Agustina et al. (2024) highlighted okara's potential as a bioresource for novel bioflocculant synthesis, promoting an integrated approach to improve both tofu quality and waste management.

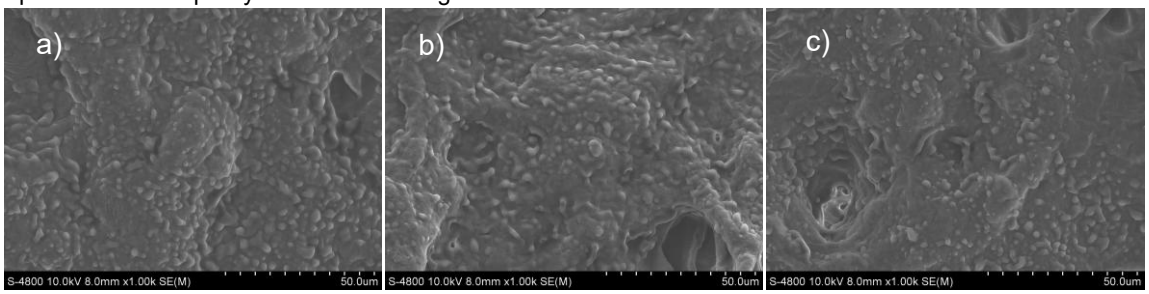

Figure 1: SEM micrographs of tofu surface a) lemon juice; b) tamarind extract; c) glucono delta-lactone (GDL)

3.3 Sensory analysis

Principal Component Analysis at pH 5.0 identified two sensory clusters: Group 1 (lime and commercial sample) and Group 2 (tamarind). Group 1 was linked to attributes like whiteness, hardness, elasticity, and soy odour, while Group 2 was associated with "cloudy white" and "yellowish" tones. Although lime and CS samples clustered together, lime tofu had a stronger soy odour and better uniformity, while CS tofu was harder and brighter. Tamarind tofu was distinct, characterized by duller colour and weaker texture. Notably, the observed colour differences in the sensory evaluation were consistent with instrumental colour measurements using the CIE system. Specifically, whiteness index (WI) values demonstrated statistically significant differences ($p < 0.05$) are shown in Table 4, further supporting the validity of the panel's assessments. However, it is important to highlight that although sensory evaluations indicated variations in firmness and elasticity among tofu prepared using lime and tamarind as coagulants, instrumental texture assessment (TPA) conducted with a texture-measuring device detected no statistically meaningful variation between these two groups ($p > 0.05$), as

presented in Table 3. As Christensen (1984) noted, texture perception involves tactile, visual, and kinesthetic cues, which may explain discrepancies between sensory and mechanical results.

4. Conclusions

This study demonstrated that tofu coagulated using natural organic acids,specifically tamarind extract and lemon juice, at pH 5.0 exhibited comparable physical and structural properties to those produced with glucono delta-lactone. The use of these natural coagulants offers a promising low-carbon alternative to synthetic agents, aligning with the growing demand for sustainable food production. Further research should focus on optimizing production processes and evaluating the full environmental impact of these coagulants, particularly in terms of carbon footprint and resource efficiency, to support their scalability in low-carbon food systems.

References

Agustina, Y.E., Heb, N., Yeap, S.K., Luthfi, A.A.I., Ding, G., Abdul, P.M., Manaff, S.F.A., Jamalig, N.S., Chen, B., & Tan, J.P., 2024, Okara: A promising resource for novel bioflocculant synthesis, Chemical Engineering Transactions, 113, 373-378.

Cao F.-H, Li X.-J, Luo S.-Z., Mu D.-D., Zhong X.-Y., Jaing S.-T, Zheng Z., Zhao, Y.-Y., 2017, Effects of organic acid coagulants on the physical properties of and chemical interactions in tofu, LWT - Food Science and Technology, 85, 58–65.

Christensen C.M., 1984, Food texture perception, Advances in Food Research, 29, 159–199.

da Silva Scherer G.C.R, Colet R., Cavalheiro D., Valduga E., Carrão-Panizzi M.C., Steffens J., Zeni J. & Steffens C., 2023, Technological characteristics of tofu from soybean coagulated with cardoon flower extract, Journal of Food Science and Technology, 60, 1323–1331.

Dang Y., Ren J., Guo Y., Yang Q., Liang J., Li R., Zhang R., Yang P., Gao X., Du S.-K., 2023, Structural, functional properties of protein and characteristics of tofu from small-seeded soybeans grown in the Loess Plateau of China, Food Chemistry: X, 18, 100689.

Duc N.Q., Que N.T., Doan N.D., Nguyen P.X., Nga L.H., 2021, Effects of pH on mơ tofu qualities, Journal of Science and Technology, 59, 196–205.

FAO, 2018, Sustainable food systems: concept and framework, FAO, Rome.

Fasoyiro S.B., 2014, Physical, chemical and sensory qualities of Roselle water extract-coagulated tofu compared with tofu from two natural coagulants, Nigerian Food Journal, 32, 97–102.

Galanakis C.M. (Ed), 2022, The Age of Clean Label Foods, Springer Cham.

Guan X., Zhong X., Lu Y., Du X., Jia R., Li H., Zhang M., 2021, Changes of soybean protein during tofu processing, Foods, 10, 1594.

Hendrawati T.Y., Audini K., Ismiyati, Ramadhan A.I., Gustia H., 2021, Effects and characterization of different soybean varieties in yield and organoleptic properties of tofu, Food Chemistry: X, 11, 100238.

Liu H.-H., Chien J.-T. and Kuo M.-I., 2013, Ultra high pressure homogenized soy flour for tofu making, Food Hydrocolloids, 32, 278–285.

Nguyet N.T.M. and Ngoc P.T.K., 2014, Comparison of recovery efficiency and structural properties of tofu obtained by different agents, Vietnam Journal of Science and Technology, 52, 346–351.

Obatolu V.A., 2008, Effect of different coagulants on yield and quality of tofu from soymilk, European Food Research and Technology, 226, 467–472.

Obulesu M., Bhattacharya S., 2011, Color changes of tamarind (*Tamarindus indica* L.) pulp during fruit development, ripening, and storage, International Journal of Food Properties, 14, 538–549.

Sanjay K.R., Subramanian R., Senthil A., Vijayalakshmi G., 2008, Use of natural coagulants of plant origin in production of soycurd (tofu), International Journal of Food Engineering, 4, 1-13.

Shangxin S., Guido J.H., Mengjie L., Fan Z., Wei Z., Xinglian X., Michael M., Chunbao L., Guanghong Z., 2016, Dietary soy and meat proteins induce distinct physiological and gene expression changes in rats, Scientific Reports, 6, 20036.

Standardization I.O.F., 2009, Cereals and cereal products – Determination of moisture content – Reference method, ISO, Geneva.

Teng L., Xin R., Kun W., Mei J., Xiaohong C., Wei L., Mingsheng D., 2015, Study of the dynamic states of water and effects of high-pressure homogenization on water distribution in tofu by using low-field nuclear magnetic resonance, Innovative Food Science and Emerging Technologies, 30, 61–68.

Zheng L., Regenstein J.M., Teng F., Li Y., 2020, Tofu products: A review of their raw materials, processing conditions, and packaging, Comprehensive Reviews in Food Science and Food Safety, 19, 3683–3714.