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Development and Evaluation of Ready to Khao Soi Sauce to Presrve Lanna Culinary Heritage and Support Gastronomy Tourism

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Khao Soi Sauce, Product Development, Consumer Acceptance, Physiochemical Properties, Traditional Cuisine

This project aimed to create a standardized, ready-to-use Khao Soi sauce that maintains the authentic flavor of Northern Thailand while strengthening its market feasibility. Three formulations, including 2%, 4%, and 6% all-purpose flour, were created and evaluated. One hundred consumers participated in sensory evaluations, while physical properties, including water activity (aw), pH, color parameters (L*, a*, b*), and chemical composition, were also investigated. The 2% flour formulation got the maximum customer acceptance, with an overall like score of 4.52 out of 5, and received positive sensory evaluations for aroma, texture, flavor, color, and appearance. The results indicated an aw of 0.78 ± 0.10, pH of 6.58 ± 0.01, and color values of L* 44.48 ± 0.11, a* 5.19 ± 0.07, b* 16.57 ± 0.09. Chemical analysis found 74.74% moisture, 15.12% ash, 1.12% protein, 21.22% fat, 18.96% fiber, and 34% carbohydrate. The findings suggest that the 2% flour formulation provides an ideal balance of sensory attractiveness and quality, facilitating its commercialization and the broader distribution of authentic Khao Soi flavors, thereby contributing to the preservation of Lanna culinary culture.

1. Introduction

Khao Soi, a signature dish of Northern Thailand, is widely celebrated for its creamy coconut curry broth and complex blend of spices. Its origins are often traced to the Yunnanese Chinese communities who migrated through historical trade routes into the Lanna region, bringing with them culinary traditions that fused with local Thai and Burmese influences (Jainan et al., 2024). Khao Soi, a representative of Northern Thailand's diverse culinary heritage, has garnered worldwide recognition in recent years, with TasteAtlas (2024) ranking it as the world's finest soup. Although it is popular, Khao Soi is less internationally recognized than other Thai dishes, such as Tom Yum or Pad Thai, partly due to its complex preparation and reliance on region-specific ingredients.

Khao Soi is a dish rooted in Lanna multiculturalism that reflects the wisdom of cultural integration in Southeast Asia and reflects the cultural exchange between Thailand, China, Burma, and India. Through trade and travel in this region, khao soi is a type of noodle-like food. But the distinctive feature is that the curry has a mixture of spices and curry paste. In the original recipe, the meat used is chicken or beef. It demonstrates the rich food cultural heritage of the Lanna multicultural wisdom in northern Thailand. Khao Soi is a dish with

a unique flavor and preparation. The main ingredients are khao soi noodles, soup, coconut milk and various seasonings such as chili stir-fried with oil, lime juice, fish sauce, sugar. Eat with side dishes such as pickled mustard greens and shallots. Which is the main side dish of Khao Soi that is commonly found

Figure 1: The Story of Khao Soi.

Khao Soi was simple, prepared only with beef or chicken pieces, but enough to please the mouths of consumers. As times changed, several other substitutes were introduced including pork and seafood. There are many different regions that alter further, the case of Chiang Mai styli for example has thick and strong stock while Fang style goes for a milder stock with different types of noodles. Thus each different style tells a different or unique northern Thailand cultural story.

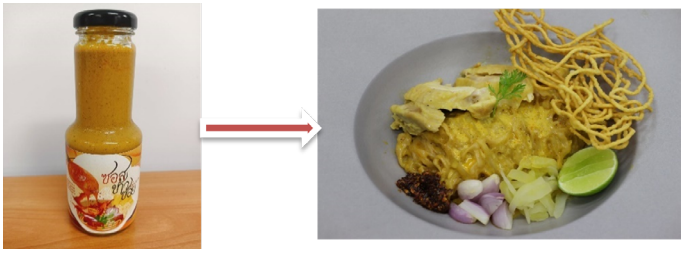

Figure 2: Khao Soi.

Although Khao Soi has been studied for its cultural significance and nutritional modifications—such as the addition of soy flour or soybean meal to increase protein content—investigations into its evolution into convenient, ready-to-use products are still lacking. Prior research has mainly focused on curry paste formulations; however, there is a significant lack of comprehensive studies on standardized Khao Soi sauces that maintain authenticity while addressing present consumer requirements for convenience, safety, and shelf stability. Furthermore, there is limited knowledge regarding the physicochemical qualities (pH, aw, moisture, color, proximate composition) of Khao Soi sauce and the impact of these parameters on its commercial viability. Likewise, smaller sensory research has investigated consumer perceptions of pre-formulated sauces, creating a significant gap in understanding market acceptance.

This work addresses these drawbacks by producing and providing standardized Khao Soi sauce with differing concentrations of all-purpose flour. The research investigation integrates physicochemical evaluations with sensory evaluations to identify the ideal formulation that matches originality, nutritional quality, and consumer demand. The research presented here integrates traditional preservation with current product development, consequently bridging the gap between cultural heritage and contemporary food innovation. Its ultimate objective is to deliver a commercially viable Khao Soi sauce that enhances market accessibility, strengthens local food industries, and promotes Thailand's culinary identity worldwide.

1.1. Objectives of this Study

Explore the ways of producing Khao Soi sauce: Look into the production process of Khao Soi sauce so that it can be made with the innovative techniques which deliver high quality whilst protecting the traditional taste for consumers.

Investigate the physicochemical parameters of Khao Soi sauce: Determine such chemical and physical properties as pH, aw value, color and nutritional components for estimation of the quality and safety of the product.

Carrying out consumer testing: Conduct such surveys and collect such data from consumers with regard to their preferences and opinions on Khao Soi sauce's aroma and general qualities as would be developed.

Disseminate the technology for the preparation of Khao Soi sauce: Pass on the technology and production processes studied to the concerned people in the food industry or other stakeholders in order to add value and increase the market for Khao Soi sauce.

In addition, this research intends to enable consumers of Khao Soi to gain more outlets for its consumption, support future trends in food processing and contribute to new food industry opportunities in Thailand.

1.2. Contribution

Scholarship on Khao Soi sauce, a traditional dish

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with greater potential in global cuisines, makes this research beneficial for those interested in commercialization of this sauce. By providing a Khao Soi sauce that is ready for use, this study tackles the problem of how the Khao Soi sauce may be most valued in terms of taste and nutrition, but would be appreciated by the target market. The following key contributions outline the impact of this research:

Preservation of Cultural Heritage: The work underscores the need to keep the Khao Soi sauce, Khao Soi and other works on its preparation in their traditional forms so as to maintain the cultural heritage of northern Thailand. The research contributes to preserving the unique regional dish and assures the authentic Khao Soi's taste is emphasized.

Innovation in Food Production: The research investigates such technologies as can improve the quality and safety of Khao Soi sauce. Illustrating qualities such as pH, aw value, and nutrition of Khao Soi sauce has not only set standards for its quality but advocates for the application of contemporary food technology in conventional cooking practices.

Market Viability and Consumer Acceptance: This constitutes an assessment of Khao Soi sauce preferences based on extensive consumer testing, thus providing useful information about market requirements. It is essential to comprehend the perception and the preferences of the consumers as it will shape any future marketing plans that would look to hand in the product in modern society but with its essence intact.

Economic Opportunities: The economic research contributes to the creation of a marketable product that could modernize Khao Soi food through the sharing of results and techniques with food industry participants. The program sustains local producers, thereby growing the Thai food market and allowing the Khao Soi sauce to be marketed to local and global consumers.

Bridging Tradition with Modern Consumption: This research is particularly relevant as it emphasizes the disparity between traditional ways of eating food and contemporary trends. There is a trend toward Khao Soi's ability to approach the growing market for easy and fast ready-to-cook meals by turning it into a sauce, while respecting its original origins.

Finally, this study provides a deeper insight into Khao Soi as a food product, and contributes to the perspective of preparing traditional delicacies as applicable to the contemporary market context, bringing in innovative ways of consumption that respect the long history of the dish while catering for modern users.

2. Literature Review

2.1. Overview of Khao Soi as a Traditional Dish from Northern Thailand

Khao Soi is a traditional noodle soup originating from Northern Thailand, renowned for its rich, creamy coconut curry broth and distinctive blend of spices. Its origins are linked to the Yunnanese Chinese immigrants who brought their culinary traditions to the region, with historical references indicating that Khao Soi was once called "Kway Teow Ho," a term that reflected its characteristic egg noodles served in curry broth. This dish typically features a combination of chicken or beef, although modern adaptations often include pork, seafood, and tofu, showcasing regional variations and evolving consumer preferences.

Figure 3: The story of Khao Soi.

The traditional preparation of Khao Soi varies across Northern Thailand, with notable styles such as the Chiang Mai variant, characterized by a thick and aromatic curry, and the Fang variant, known for its lighter broth and the use of different noodle types. The cultural significance of Khao Soi is profound, as it represents a fusion of local ingredients and culinary practices that have been influenced by surrounding cultures. As such, Khao Soi has become an integral part of Northern Thai identity and cuisine.

2.2. Importance of Khao Soi Sauce in Culinary Practices and Growing Interest in Commercialization

The emergence of Khao Soi sauce as a commercial product underscores the increasing interest in traditional dishes adapted for contemporary consumer lifestyles.

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This interest is driven by an increasing demand for convenience foods that retain authentic flavors. As culinary practices evolve, there is a notable shift toward innovating traditional recipes to create products that cater to broader demographics and facilitate easier meal preparation. Khao Soi sauce presents an opportunity to capture the essence of the traditional dish while offering a shelf-stable, ready-to-use product that aligns with contemporary eating habits.

Market studies indicate that while there is widespread recognition of Khao Soi as a beloved dish, it often remains overshadowed by more popular Thai eats such as Tom Yum and Pad Thai. This disparity in recognition underscores the potential for commercialization of Khao Soi sauce, particularly as consumers seek convenience without sacrificing authenticity in their culinary choices. By transforming Khao Soi into a sauce, the culinary industry can not only preserve the flavors and traditions of this regional dish but also increase its market reach and profitability. This move towards commercialization reflects a broader trend wherein traditional foods are reimagined for mainstream acceptance, thereby enhancing their market viability and cultural relevance.

2.3. Historical Background

Exploration of the origins of Khao Soi. "Khao Soi" is one of the Lanna foods that has been influenced by cultures from many sources, both Chinese culture and Shan food culture, especially the Chinese cultural influence from Yunnan people from the past trade routes. The Yunnanese Muslim group, or what the Lanna people call "Hor Chinese", is the main cultural group that brought food culture such as Khao Soi into Lanna territory through the trade route from Yunnan Province to Chiang Mai and down to Mawlamyine in Mon State since the beginning of the 16th century onwards. Until the mid-19th - early 20th century, the Hor Chinese expanded the trade routes into 3 routes, with the main trade route being in Chiang Mai, which was the main trade route and where they settled (now Ban Hor, Charoen Prathet Road 1). In the year 1915, the Hor Chinese received permission from the ruler of Chiang Mai to settle and work as a main occupation. One of the trades of the Hor Chinese who settled in Chiang Mai was selling food, and the food they sold was "Khao Soi", using a fresh noodle-making process that is similar to clear noodle soup. The name Khao Soi comes from the noodle-making process in ancient times, when there were no machines to save labor in production like today. In the past, Khao Soi noodles were made by mixing wheat flour, eggs, salt, and water together, then kneading and pressing the dough into sheets. Then, a knife was used to cut the dough into small pieces similar to noodles. This production process gave rise to the name of this dish, "Khao Soi." In addition, there is a concept that the origin of Khao Soi was influenced by Burmese food culture, originating from a dish called "Ohn-No Khao Swe", which is similar to Khao Soi but does not emphasize the spices as much as Lanna Khao Soi. From all of the above, it is evident that Khao Soi is a food with a long history in Southeast Asia, particularly in China, Yunnan, and Burma. It is unique because it is a combination of cultures from many countries, facilitated by trade and travel, including the value in terms of knowledge of food culture that allows for the perfect blending of various cultures, resulting in a distinctive food that is popular with both Thais and foreigners today.

"Khao Soi" is a type of noodle dish that is similar to general noodles found in every region, but its distinctive feature is the curry soup that contains specific spices and curry paste. In addition, there are many types of Khao Soi, such as Khao Soi Moo, Khao Soi Nuea, Khao Soi Kai, showing the cultural heritage of food that is rich in the wisdom of Lanna multiculturalism in the northern part of Thailand. Khao Soi is a dish with a unique flavor and preparation. The main ingredients are Khao Soi noodles, soup, coconut milk, and various seasonings. It is served with side dishes such as pickled mustard greens and shallots, which are the main side dishes of Khao Soi that are commonly found.

Figure 4: The story of Khao Soi.

2.4. Influence of Burmese cuisine on Khao Soi sauce development.

Khao Soi is a Lanna dish with a unique taste from a combination of spices, coconut milk, and various types of meat, which is popular among both locals

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and tourists. However, preparing and cooking Khao Soi in the traditional way can be time-consuming and requires many ingredients, making it quite difficult for everyday life or for general consumers who have limited time. In order to meet the needs of today's consumers who want convenience and speed, while still wanting the same rich and well-rounded taste, the development of ready-to-use Khao Soi sauce is a way to make Khao Soi cooking easy and convenient. It not only helps to perfectly preserve the original taste of the food, but also helps to extend the shelf life of the product. Ready-to-use Khao Soi sauce is an innovation in the Thai food industry, adding value to local food products and helping to preserve this recipe in an era when people have less time to cook. Having a convenient product allows the new generation to still have access to and be familiar with Khao Soi without having to cook complicated food. It also creates business opportunities for entrepreneurs in the food industry, enabling them to present unique products and promote exports to the global market, thereby expanding the market and reaching a wider range of consumers both domestically and internationally.

2.5. Ingredients and Preparation

Key ingredients used in Khao Soi sauce. Ingredients similar to Khao Soi are like Khao Soi curry paste, coconut milk, coconut milk, light soy sauce, dark soy sauce, flat yellow noodles, vegetable oil for frying. Ingredients for Khao Soi curry paste: large dried chili, peeled, 1 Chako (also known as black cardamom, grass jelly, etc.), coriander seeds, sliced old ginger, small shallots, coriander roots, sliced fresh turmeric, ground salt, curry powder, garlic, fried garlic. Side dishes are usually boiled, pickled mustard greens, sliced shallots, limes, pieces of fried dried chili, which are ingredients. The reason is purely about maintaining the taste and unique smell of Khao Soi. The source of ingredients that can be found here is because today's consumers are more concerned about their health and consumption. They prefer to use ingredients that are grown without using chemicals. Processed meals Processed foods Organic ingredients rely on the abundance of living things in water and soil. The value of the characteristics of some foods lies in the tradition of research and innovation, aiming to create benefits for the environment and consumption (Alrashidi, Faris, & Arafat, 2022). To make quality Khao Soi that is good for the health of consumers, using spices to add flavor helps to make Khao Soi more interesting. Khao Soi noodles are made from good quality wheat flour, mixed with fresh chicken or duck eggs, and rolled with a noodle making machine, resulting in chewy and soft noodles with a unique flavor. The taste and richness of the flavor of Khao Soi is well-rounded. It comes from the combination of a special curry paste recipe that contains dried chili, shallots, garlic, and various spices, which is a unique identity that is difficult to imitate. The difference in taste, each recipe of Khao Soi has a slightly different taste.

Figure 5: Khao Soi Curry Paste Ingredients (Chongchitnant, 2023).

2.6. Variations in Preparation Methods Across Regions

The traditional way of making Khao Soi reflects the meticulousness in cooking. Using unique tools such as a mortar, pestle or clay pot will add interest to the Khao Soi making process. Making Khao Soi takes time and meticulousness, especially the roasting of curry paste, which must be roasted until fragrant and beautifully colored to obtain Khao Soi soup with a beautiful color, fragrant with spices and coconut milk. The spiciness of the curry paste will help maintain the identity and originality of Khao Soi. Start by making the Khao Soi curry paste by roasting each ingredient over low heat until fragrant and slightly burnt. Dried chili, wild bean seeds, coriander seeds, ginger, shallots, coriander root, and fresh turmeric, put the roasted dried chili in a mortar with salt. Add the roasted coriander seeds and wild bean seeds and continue to pound. Add curry powder and continue to pound until fine. Add the shallots, ginger, coriander root and turmeric, and pound all together until fine and set aside. Set a pot over medium heat, add the coconut cream and coconut milk. When the coconut milk starts to boil and separates slightly, add the chicken legs to boil. Scoop the separated coconut milk into the pan, add the curry paste and stir-fry until fragrant,

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scoop the stir-fried curry paste into the pot with the boiling chicken legs, mix well, reduce the heat to low, cover the pot and simmer for about 1 hour. Season with light soy sauce, dark soy sauce, add coconut cream and set aside. Sprinkle garlic in the not-so-hot oil. Heat a pan over low heat until the garlic starts to turn light yellow, then turn off the heat. Drain the noodles and fry the noodles in hot oil until golden brown. Scoop out and drain the oil. Boil the noodles in boiling water, mix the fried garlic oil with the noodles to prevent the noodles from sticking together. Arrange the noodles in a bowl, scoop the chicken legs and khao soi curry over, sprinkle with crispy fried noodles, serve with shallots, sour pickled mustard greens, boiled eggs and fried dried chili powder.

2.7. Nutritional Aspects

Analysis of the nutritional value of the ingredients.

Figure 6: Analysis of the Nutritional Value of the Ingredients.

Nutrition Facts Nutritional value in 100 grams of Khao Soi: 1. Energy 138.11 kilocalories 2. Fat 13.55 grams 3. Protein 2.64 grams 4. Dietary fiber 2.82 grams 5. Saturated fatty acids 9.41 milligrams.

There are researches related to nutritional value, namely (Thakaew & Chanta-In, 2008) partial replacement of wheat flour with soybean meal in Khao Soi noodles, with the aim to reduce waste, i.e., soybean meal from tofu factory. It was found that Khao Soi noodles replaced with 10% soybean meal had a tensile force of Khao Soi noodles equal to 38.06±6.52 g-force and received an acceptance score no different from the formula that did not use it. However, since the Khao Soi color was not acceptable, the Khao Soi color was improved by using natural color from safflower at concentrations of 0, 2.5, 5.0, and 7.5 percent. It was found that at a concentration of 5 percent, the highest acceptance score was obtained, with L* a* b* values of 46.52±0.34, 0.21±0.19, and 16.11±0.30, respectively. Takham (2013) used soybean flour as an ingredient in Khao Soi noodles and water, developed Khao Soi noodles with increased nutritional value, and developed Khao Soi recipes that were nutritious and suitable for patients. Khao Soi is a food with high nutritional value in terms of energy mostly from fat and carbohydrates, which are derived from the main components of carbohydrates from Khao Soi noodles, fat from coconut milk in the curry sauce used for topping, and from the popularity of local people, Khao Soi has been made into one of the lunch menus for patients who are hospitalized. However, the original Khao Soi noodles have wheat flour as the main ingredient, modified by using soy flour as an ingredient in making Khao Soi noodles to increase nutritional value, and using soy flour as an ingredient in making the curry sauce mixed with coconut milk to increase nutritional value and reduce the problem of excess energy from using coconut milk alone. This research and invention has resulted in Khao Soi noodles with increased nutritional value, especially protein from soybeans, which can create a new Khao Soi recipe in the form of Maharaj Nakorn Chiang Mai Hospital and is satisfactory to patients who receive treatment services from the hospital. Wattanachai & Manomainukul (2013) Developing ready-to-cook Khao Soi curry paste products To develop Khao Soi curry paste products in a form that is convenient for cooking When compared to commercial Khao Soi, it was found that the standard Khao Soi recipe received only a slight liking score. Therefore, the recipe developer adjusted the recipe using the Just about right test, finding that sweetness should be increased and spiciness reduced. Therefore, the appropriate amount of chili peppers was found. The most suitable amount was 4.50 percent of the total amount of curry paste and other ingredients were as follows: chicken stock cube 6.0 percent, concentrated chicken stock 9.0 percent, palm sugar 11 percent, vegetable oil 13 percent, light soy sauce 14 percent, fish sauce 14 percent, fresh curry paste 33 percent. The color values L* a* b* were 20.59, 13.59 and 7.76, respectively. The water activity was 0.7, pH was 5.21, and the total solids was 30.9 degree Brix. The sensory test revealed a moderate level of liking.

2.8. Benefits and Challenges Related to Certain Components

Properties of Khao Soi: The ingredients make Khao Soi have beneficial properties from Chako, Chako or Jelly Grass Jee, which is from the fruit and the Jelly Grass plant, which is a brown herbaceous plant, the size of a tamarind. It is used as a fragrant food in food and has a slightly spicy taste. The seeds and peel contain aromatic substances that help expel coldness and moisture from the body, making the body warm, helping to expel

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phlegm, helping to digest food, nausea, vomiting, indigestion, and treating stomach bloating. Chili peppers have a spicy taste, help stimulate appetite, expel gas, and help digest. Galangal has a spicy and hot taste, helps expel gas, expel toxins from the uterus, expel gas in the intestines. Turmeric treats stomach ulcers, stimulates appetite and sweats. Shallots have a spicy taste, relieve fever due to phlegm, nourish the elements, and treat colds. Coriander helps dissolve phlegm, treat measles, expel sweat, expel gas, treat flatulence, and increase appetite. Garlic has a spicy taste, expels gas in the intestines, treats coughs, expels phlegm, helps digestion, and treats skin diseases. Garlic oil has the effect of inhibiting the growth of fungi, bacteria, and viruses, and lowers blood sugar. Reduce fat in blood vessels.

Figure 7: "Chako Seeds" Are An Important Spice for Khao Soi.

2.9. Recipe Development Strategies for Sauces

Khao Soi is one of the most distinctive dishes from Northern Thailand, characterized by its rich coconut milk-based curry and egg noodles. Its origins are widely linked to the culinary exchanges between Yunnanese Chinese traders, Lanna communities, and Burmese influences, reflecting the broader multiculturalism of the region (Chongchitnant, 2023; Jainan et al., 2024). While the dish is strongly embedded in local identity, its preparation is time-consuming, requiring complex spice blends and region-specific ingredients. This complexity has limited its widespread adoption outside specialty restaurants, despite gaining global recognition; TasteAtlas (2024) recently ranked it the world's best soup. The tension between cultural authenticity and accessibility highlights the potential of ready-to-use Khao Soi sauce as an innovative solution that preserves tradition while responding to modern consumer demands.

Previous academic research on Khao Soi has primarily focused on its nutritional modification and cultural preservation, rather than on commercial product development. For instance, Thakaew & Chanta-In (2008) studied the partial substitution of wheat flour with soybean meal to improve nutritional value in Khao Soi noodles, while Takham (2013) incorporated soy flour into both noodles and curry to enhance protein content for hospital patients. Wattanachai & Manomainukul (2013) developed a ready-to-cook curry paste, identifying adjustments in sweetness and spiciness that improved consumer acceptance. These studies provide valuable foundations but remain narrow in scope, focusing on noodles or curry paste, and rarely addressing the formulation, physicochemical stability, or consumer perception of Khao Soi sauce itself.

The broader literature on sauce and condiment development provides insights relevant to Khao Soi product innovation. Hydrocolloids such as xanthan gum have been shown to improve texture and stability in semi-instant curries like Kaeng Om (Thongsukngam, 2022), while cassava flour fortification in teriyaki sauce demonstrated potential for improving viscosity and maintaining product consistency during industrial processing (Auppathak et al., 2023). These formulation strategies highlight how stabilizers and starch-based modifiers can address challenges in texture, separation, and shelf life—critical considerations for Khao Soi sauce, which relies on a coconut milk base prone to instability during storage.

Equally important is the role of sensory evaluation in determining consumer acceptance. Hedonic scales, preference testing, and just-about-right assessments are widely applied across food studies to identify the balance of flavor, aroma, and texture that resonates with consumers. Ruchikachorn et al. (2005) optimized peanut sauce formulations through consumer-driven sensory analysis, while Rajchasom, Seelum, & Takonkeaw (2021) used similar techniques to evaluate seasoning powders derived from local fermented soybeans. These studies highlight the importance of structured sensory methodologies in refining traditional foods into commercially viable products. For Khao Soi sauce, which must preserve a distinctive flavor profile while adapting to modern consumption, sensory evaluation plays a central role in bridging authenticity with market readiness.

Food processing techniques for shelf-life extension further strengthen the potential of traditional foods for commercialization. Research on ready-to-use chili sauces and seasoning powders (Rajchasom et al., 2021) demonstrates how moisture control, pasteurization, and the inclusion of hydrocolloids

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can enhance microbial safety and extend product stability. A prior study emphasized that Southeast Asian diets can be adapted for modern food systems without losing their cultural significance, provided appropriate preservation techniques are applied. These insights are particularly relevant to Khao Soi sauce, where maintaining pH, water activity, and nutritional quality is essential for consumer safety and international market viability.

In summary, while Khao Soi has been studied as a cultural and nutritional symbol, the literature reveals clear gaps in its scientific exploration as a ready-to-use sauce. Few studies have rigorously examined its physicochemical properties, standardization strategies, or consumer acceptance. Lessons from related sauce development—ranging from hydrocolloid incorporation to sensory-driven formulation—demonstrate pathways for innovation that balance tradition with modern food industry requirements. Building on these gaps and insights, the present study seeks to establish standardized formulations of Khao Soi sauce, evaluate their physicochemical properties, and assess consumer acceptance to determine their commercial potential.

3. Research Methodology

3.1. Determination of Optimal Amounts of All-Purpose Flour in Khao Soi Sauce

In this study, a standard Khao Soi recipe was altered in order to formulate a Khao Soi sauce containing different proportions of all-purpose flour. The Khao Soi sauce was composed of three levels of the all-purpose flour, which were 2%, 4% and 6% of the total composition of the ingredients. Shown in Table 1. Then start making the khao soi sauce following the steps for making the khao soi sauce as shown in Figure 8. A Randomized Complete Block Design (RCBD) was applied to evaluate three formulations of Khao Soi sauce (2%, 4%, and 6% all-purpose flour). Blocks were defined by session to reduce variability from environmental and panelist-related factors. RCBD was selected because it provides stronger control over random variation than a completely randomized design, increasing the reliability of treatment comparisons in sensory studies. A Randomized Complete Block Design (RCBD) was used to organize the experimental design of the research in order to be able to evaluate the sensory characteristics of color, aroma, flavor, taste, and texture, and overall acceptability.

3.2. Sensory Evaluation

Consumer acceptance was assessed with a 5-point Hedonic Scale (1 = dislike very much, 5 = like very much). Although the 9-point scale offers finer resolution, the 5-point scale was preferred for its simplicity and suitability for non-trained consumer panels. To mitigate the scale's reduced sensitivity, a large sample size of 100 participants was recruited from Suan Dusit University, Lampang. Panelists were screened for familiarity with Thai cuisine and absence of ingredient allergies. While untrained, all received standardized instructions and palate cleansers to ensure consistency. Samples were served in random order under blind coding.

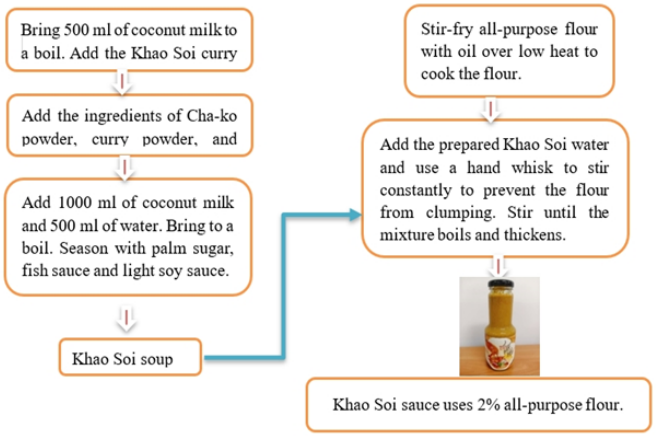

Figure 8: Steps for Making Khao Soi Sauce.

Table 1: Shows the amount of All-Purpose Flour used in Khao Soi Sauce.

Raw Material	Amount of All-purpose Flour used in Khao Soi Sauce		
	Formula 1 2% (g)	Formula 2 4% (g)	Formula 3 6% (g)
Khao Soi curry paste	50	50	50
coconut milk	1500	1500	1500
water	500	500	500
Cha-ko powder	2	2	2
Curry powder	10	10	10
Khao Soi Powder	15	15	15
Palm sugar	90	90	90
fish sauce	35	35	35
soy sauce	35	35	35
All-purpose flour	44.74	89.48	134.22

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3.3. Analysis of Physical Quality and Approximate Chemical Composition of Khao Soi Sauce Products

Analyze the physical quality and approximate chemical composition of Khao Soi sauce products developed from standard recipes, as analyzed by 50 panelists. The method used for testing each item was the reference test method as shown in Table 2.

Table 2: List of Analytical Items and Methods used for Testing.

Analysis List	Test/Reference Method
Water activity (a_w)	Measured using an aw meter (Aqualab PawKit model).
Color	Measured with a colorimeter, model 3NH NH Series, displaying the measured value of L* brightness (0 = dark, 100 = bright) a* + = red, - = green b* + = yellow, - = blue
Moisture	Moisture content analysis according to AOAC (2000)
Crude fat	Fat quantification analysis by SoxtecTM extraction (AOAC, 2000)
Crude fiber	Fiber content analysis using FibertecTM System (AOAC, 2000)
Total ash	Analysis of ash content using Muffle Furnace (AOAC, 2000)
Crude protein	Protein quantification analysis by Kjeldahl method (AOAC, 2000)
Carbohydrates	Carbohydrate quantification analysis by calculation (By difference) (AOAC, 2000)

3.4. Consumer Acceptance Study (Consumer test) on Khao Soi Sauce Products

The research project received certification from the Human Research Ethics, Health Science Branch, with certification number SDU-RDI-HS 2024-032 and project code HS037/2567, following the testing of 100 consumers to study consumer acceptance of Khao Soi Sauce products. The testers will receive samples along with a product acceptance questionnaire, which will be administered randomly at Suan Dusit University, Lampang Educational Center. The results were analyzed to find the percentage of consumer acceptance test results for Khao Soi Sauce samples packed in clear plastic cups with lids and labeled with a 3-digit sample code. Then, the samples were served to the testers along with drinking water for rinsing their mouths.

3.5. Transfer of Technology for Developing Rice Sauce Products

By organizing a workshop, 1 time, 20 participants at Suan Dusit University, Lampang Educational Center, Mueang District, Lampang Province.

4. Research Results

4.1. Results of the Study on the Appropriate amount of All-purpose Flour in Rice Sauce Products

The sensory evaluation results of Khao Soi sauce products with 3 levels of different percentages, namely 2, 4 and 6 percent, found that the amount of all-purpose flour added at 2 percent, consumers gave the highest score in terms of smell, texture, taste, color, appearance and overall liking as very much to very much, with the mean values of 3.80, 3.98, 4.32, 4.34, 4.42 and 4.52, respectively, as shown in Table 4. When the analysis of variance was conducted and the statistical differences were compared, it was found that the taste, color, appearance and overall liking were significantly different at the 0.05 level, while the smell and texture were not significantly different at the 0.05 level because the tasters gave the highest score for Formula 1 because it had the same appearance, color and taste as the Khao Soi sold in general markets. Therefore, Formula 1 was selected as the next Khao Soi sauce recipe.

Figure 9: The Sensory Quality of Four Rice Sauce Formulas.

Table 3: Shows the Sensory Quality of Four Rice Sauce Formulas.

Attribute	Amount of All-purpose Flour used in Khao Soi Sauce		
	Formula 1 2%	Formula 2 4%	Formula 3 6%
Appearance	$4.42^{a}\pm0.54$	$3.99^{b}\pm0.77$	$4.06^{b}\pm0.74$
Color	$4.34^{a}\pm0.52$	$3.94^{b}\pm0.84$	$4.12^{ab}\pm0.73$
Smell^{ns}	3.80 ± 0.83	3.68 ± 0.96	3.86 ± 0.90
Taste	$4.32^{a}\pm0.55$	$4.02^{b}\pm0.71$	$3.76^{b}\pm0.87$
Texture^{ns}	3.98 ± 0.87	4.06 ± 0.84	3.88 ± 0.77
Overall	$4.52^{a}\pm0.54$	$3.92^{b}\pm0.94$	$4.12^{b}\pm0.72$

Note: Different horizontal letters mean values that are statistically significantly different at the 0.05 level. ns means values that are not statistically significantly different at the 0.05 level.

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4.2. Results of the Study of Physical and Chemical Quality of Khao Soi Sauce Products

The results of the analysis of the quality of Khao Soi sauce products are shown in Table 4 and Table 5.

Table 4: Results of physical quality analysis of Khao Soi.

Physical Quality	Amount of All-purpose Flour used in Khao Soi Sauce		
	Formula 1 2%	Formula 2 4%	Formula 3 6%
a_w	0.78±0.10	0.86±0.01	0.87±0.01
pH	6.58±0.01	6.80±0.02	6.65±0.01
L*	44.31±0.12	44.48±0.11	49.03±0.26
a*	5.19±0.07	4.96±0.13	2.14±0.34
b*	16.57±0.09	26.27±0.27	19.83±0.18

The results of physical quality analysis of Khao Soi sauce formula 1 at 2% all-purpose wheat flour level showed that the a_w value was 0.78±0.10, the brightness value (L*) was 44.48±0.11, the green value (a*) was 5.19±0.07 and the yellow value (b*) was 16.57±0.09.

Table 5: Results of Chemical Quality Analysis of Khao Soi Sauce.

Chemical Quality	Amount of All-purpose Flour used in Khao Soi Sauce		
	Formula 1 2%	Formula 1 2%	Formula 1 2%
Moisture (percent)	74.74	75.05	74.92
Ash (percent)	15.12	14.95	14.56
Protein (percent)	1.12	1.82	1.67
Fat (percent)	21.22	21.67	21.19
Fiber (percent)	18.96	17.00	18.50
Carbohydrates (percent)	34.00	35.00	34.00

The results of chemical quality analysis of Khao Soi sauce supplemented with 2 percent all-purpose wheat flour found that it had a moisture content of 74.74 percent, 15.12 percent ash, 1.12 percent protein, 21.22 percent fat, 18.96 percent fiber and 34 percent carbohydrates.

4.3. Consumer Acceptance Study Results for Khao Soi Sauce Products

From the sensory quality in terms of liking, color, taste, aroma, and overall liking of the testers towards Khao Soi sauce, using a random questionnaire at Suan Dusit University, Lampang Educational Center, with a target group of 100 people, it was found that most of the respondents were female, accounting for 65 percent, most were aged 21-30 years, accounting for 63 percent, most had a bachelor's degree, accounting for 61 percent, were students, accounting for 35 percent, and most had an average monthly income of 10,001-15,000 and 15,001-20,000. The details are shown in Table 6 and Figure 10.

4.4. Technology Transfer for Khao Soi Sauce Product Development

The technology transfer for Khao Soi Sauce product development was carried out on September 25, 2024 at the International Food Laboratory 2, Suan Dusit University, Lampang Educational Center, as shown in Figures 13 and 14. There were 20 trainees, most of whom were female, accounting for 85 percent, and male, accounting for 15 percent. It was found that the satisfaction level of participants in the Khao Soi Sauce workshop was at a very high level, accounting for 100 percent.

Table 6: General Information of Respondents, Khao Soi Sauce Products.

Basic Personal Information		Percentage
1. Gender	Female	65
	Male	35
2. Age	Under 20 years old	8
	21-30 years old	63
	31-40 years old	18
	More than 40 years old	11
3. Education	Below Bachelor's Degree	35
	Bachelor's Degree	61
	Above Bachelor's Degree	4
4. Occupation	Students	55
	Civil servants/government employees	14
	Private company employees	13
	personal business	19
5. Monthly income	Less than 10,000 baht	14
	10,001-15,000 baht	32
	15,001-20,000 baht	32
	More than 20,000 baht	22

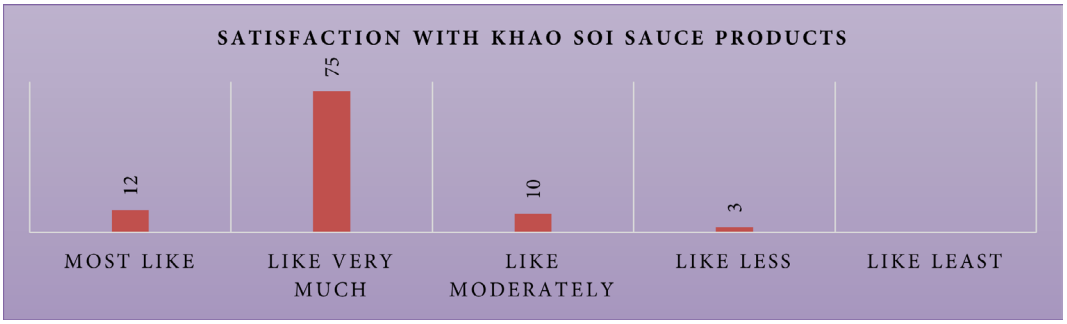

Figure 10: Graph Showing the Influence of Preference on Khao Soi Products.

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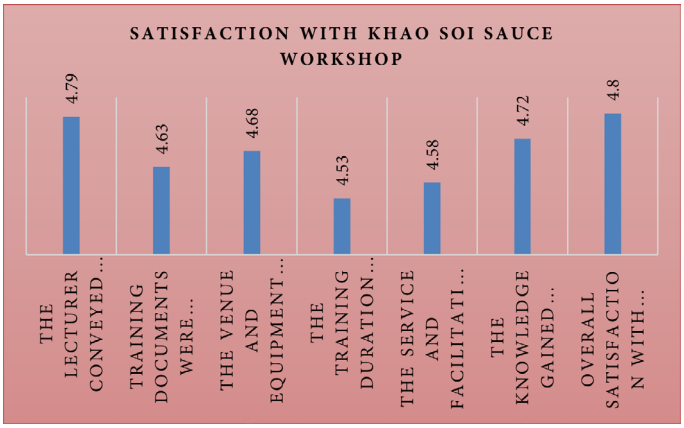

Figure 11: Graph Showing the Average Satisfaction of Participation in the Khao Soi Sauce Workshop.

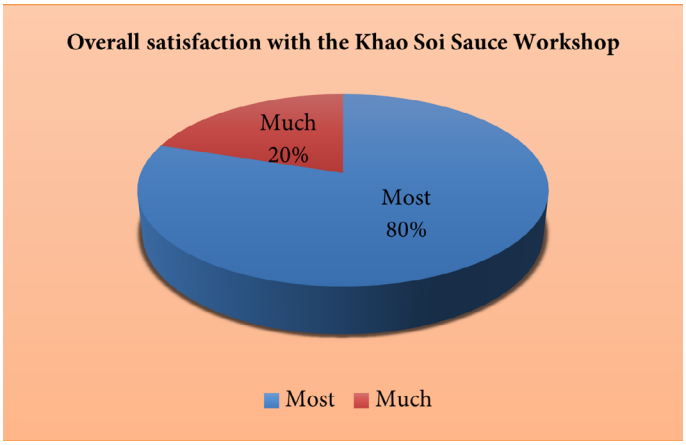

Figure 12: Graph Showing the Percentage of Satisfaction of Participants in the Khao Soi Sauce Workshop.

5. Discussion and Conclusion

This study developed and evaluated standardized formulations of Khao Soi sauce, focusing on sensory acceptance and physicochemical properties. Results demonstrated that the 2% all-purpose flour formulation was the most preferred by consumers, achieving high scores for flavor, color, and overall liking. This finding highlights the importance of balance in formulation: while flour contributes to sauce thickness and stability, excessive addition (4% and 6%) negatively affected mouthfeel and flavor perception. Comparable studies on other traditional sauces have similarly shown that moderate use of thickeners or hydrocolloids enhances product quality, whereas excessive incorporation compromises sensory appeal (Auppathak et al., 2023; Thongsukngam, 2022).

Physicochemical analysis reinforced the sensory results. The 2% flour sauce exhibited a water activity (aw) of 0.78 and a pH of 6.58, values that align with safe and stable ready-to-use sauces. Its proximate composition, including high moisture and fat content alongside moderate carbohydrate and fiber levels, resembles traditional Khao Soi while offering potential for controlled nutritional adjustments. The color parameters (L* 44.48, a* 5.19, b* 16.57) indicated product consistency and visual appeal comparable to commercial curry sauces that rely on natural spice pigments for attractiveness (Jangphonak, 2017). These properties suggest that the developed formulation can retain authenticity while meeting consumer expectations for convenience and quality.

The consumer acceptance data demonstrated a strong overall preference for the 2% formulation, with flavor and appearance identified as the most influential attributes. These findings align with studies of peanut sauce (Ruchikachorn et al., 2005) and seasoning powders derived from fermented soybeans (Rajchasom et al., 2021), which found that authenticity and familiarity drive consumer satisfaction in traditional food products adapted for new formats. The results confirm that Khao Soi sauce, when carefully formulated, can successfully bridge culinary heritage with modern product demands.

Nevertheless, several limitations must be acknowledged. The consumer panel was limited to a university population, which may not reflect broader demographics or international consumers. Shelf-life testing under different storage conditions was not conducted, leaving questions about microbial stability and long-term preservation. Finally, the use of a 5-point Hedonic Scale, although suitable for general consumer testing, may have lacked sensitivity to detect subtle sensory differences between formulations.

Despite these limitations, this research provides important contributions to the literature on traditional food product development. It demonstrates how systematic formulation, physicochemical characterization, and consumer testing can transform Khao Soi—a culturally significant dish—into a standardized, ready-to-use product with strong commercial potential. The findings suggest that moderate flour addition (2%) optimally balances sensory quality with product stability.

Future work should expand sensory testing to more diverse demographic groups, conduct extended shelf-life and microbial safety evaluations, and explore the use of natural stabilizers such as xanthan gum or carrageenan for improved texture and preservation. Additionally, cross-cultural consumer studies could

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assess the global market potential of Khao Soi sauce as part of Thailand's growing soft power in gastronomy.

In conclusion, this study bridges tradition and modernity by demonstrating the feasibility of a standardized Khao Soi sauce that retains cultural authenticity while meeting the practical and sensory demands of contemporary consumers. With further refinement and industrial validation, Khao Soi sauce could become a flagship example of how regional heritage foods can be adapted for global markets.

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