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Supporting Sustainable Development by Identifying Ways to Enhance and Conserve Local Food Wisdom, Loei Province, Thailand

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Abstract: Traditional diets are generally nutrient-rich and utilise locally available resources. Strategies to help conserve local food wisdom and increase its value could facilitate a reduction in the burden of all forms of malnutrition and achieve global goals. Our objectives were to: (1) investigate the variety of local foods and food preparation methods in Loei province, Thailand; (2) investigate ways of increasing the nutritional, social, and economic value of local food in this province; and (3) construct a local food database to catalogue and conserve the local food wisdom. Nine out of fourteen districts in Loei province were purposively selected. All were designated key sustainable tourist destinations and represented a range of terrains. There were 423 interview participants, representing all villages in one subdistrict of each of the nine selected districts. We also conducted nine focus group discussions with a total of 90 participants. Data were analysed and categorised, based on the content analysis technique, and we created an online database of the catalogued recipes. There were 240 dishes, placed into seven categories of recipe type. Many of the characteristics of the local dishes from Loei province today remain closely connected to the history of this part of Thailand. We identified that the value of local foods could be improved by investing in technology used for home preservation, actively engaging younger generations to improve the transfer of local food wisdom, investment in technology to utilise local biodegradable materials, and tourist activities based around local food heritage. Future work will involve further development of the local food database, and research to evaluate the application of the database. Moreover, this research can serve as a model for retaining and valuing local food wisdom elsewhere, to promote food security, combat malnutrition, and benefit the local economy.

Keywords: traditional diet; food wisdom; food preparation; northeastern region of Thailand; global goals; nutritional; social and economic value

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1. Introduction

The Sustainable Development Goals are intended to forge a pathway towards an equitable, healthy, and prosperous outlook for future generations [1]. The second sustainable Development Goal (SDG 2) features eight specific targets, five of which aim to: provide universal access to safe and nutritious food, eliminate all forms of malnutrition, support small-scale food producers, enhance sustainable food production, and maintain genetic diversity in food production [2]. This goal was established to alleviate global malnutrition by reducing inequalities in the use of resources.

Thailand has made notable progress on reducing poverty (SDG 1) and ensuring access to clean water and sanitation (SDG 6), guided by its sufficiency economy philosophy which emphasises a people-centred development approach and aims to empower communities [3]. Nevertheless, the country has made less progress towards achieving SDG 2 and other global goals [3]. Its transition from a low- to upper-middle-income country occurred over a short period of 40 years [4]. This transition coincided with improvements in transport and communication networks and changes in lifestyle. The liberalisation of trade, investment, and labour movement in ASEAN countries has led to an increase in social relationships within the region [5], which have been further strengthened by the growth of social media [6]. At the same time, the availability of relatively cheap ultra-processed food has increased. The diets of local people may be changing, with people consuming more processed food and purchasing ready-made food from markets rather than preparing food at home, foraging food, or taking it from home gardens [7].

However, a move away from consuming a local traditional diet coupled with a shift towards a sedentary lifestyle is typically associated with an increase in the burden of malnutrition and non-communicable disease [8]. The triple burden of malnutrition, namely undernutrition (underweight, stunting and wasting), overnutrition (overweight and obesity) and micronutrient deficiencies, is an increasingly important public health problem [9]. Over one third of adults in Thailand are overweight, while anaemia among both non-pregnant and pregnant women continues to increase [10]. In Thai children aged 24–35 months, the prevalence of stunting and overweight is 10.9% and 11.3%, respectively [11]. Malnutrition is more marked in some provinces of Thailand compared with others. In Loei province, around 25% of school children and adolescents are stunted or relatively stunted, nearly 20% of pregnant women have anaemia, and at least 45% of working-age adults and older adults are affected by overnutrition [12]. We can facilitate a reduction in the burden of all forms of malnutrition and achieve global goals by retaining and promoting traditional diets, which are generally nutrient-rich and utilise locally available resources.

Loei province, in the upper north-eastern region of Thailand, possesses a rich history, local heritage, and food culture. From the mid-fourteenth century to the early eighteenth century, this area was part of the Lan Xang Kingdom [13]. Parts of Lao PDR, as well as areas of the north-eastern region of Thailand, were once part of this ancient kingdom [14]. Today, the Mekong River, on the northern edge of Loei province, demarcates the border between Thailand and Lao PDR. Loei province has a diverse terrain consisting of mountain ranges and fertile plains along with variations in seasonal temperature [15,16]. Inevitably, the province is hospitable to a wide variety of local plants. Many households in Loei province are dependent on agriculture for their primary income, and there are high levels of household debt [17]. Notably, eco-tourism can make a significant contribution to the local economy, as the province has well-preserved natural habitats and many unique local customs [18]. These include traditional local foods and food preparation methods, which have given rise to a diverse cuisine that has historically made use of the vast array of locally grown edible plants, together with fish, shellfish, and some animal products.

Several factors strongly support the need for strategies to help conserve local food wisdom and increase its value. Firstly, a statement issued by the Food and Agriculture Organisation Director-General encourages populations to consume fresh locally produced food to combat malnutrition [19]. Secondly, it is crucial to preserve traditional food wisdom for future generations, support local farmers, and retain diversity in local food production. Thirdly, local ecosystems are readily accessible sources of nutritionally rich plant species and varieties, so strengthening and intensifying local food products can even mitigate the adverse effect of global food shocks [20]. This realisation is even more pertinent considering the global disruption caused by the coronavirus pandemic. Finally, the rising cost of many foods has been predicted to continue, which inevitably will have the greatest impact on the nutritional status of low-socioeconomic sectors of society [21].

Therefore, the objectives of this community-based participatory research were to: 1 investigate the variety of local food and food preparation methods in Loei province, Thailand; 2 investigate ways of increasing the nutritional, social, and economic value of local food in this province; and 3 construct a local food database to catalogue and conserve the local food wisdom. The research approach enabled the researchers, experts, and community stakeholders to engage as equal partners during the research process.

2. Materials and Methods

2.1. Study Site

The north-eastern region of Thailand is composed of 20 provinces, with dialects and histories that are distinctly different from those of other regions. Loei province is in the upper part of this north-eastern region (Figure 1). In 2018, its total population was 642,773 [22]. This province was purposively selected for this research, due to its particularly unique local heritage, customs, and cuisine.

Each province in Thailand is comprised of districts, which in turn are made up of subdistricts that contain villages. Nine of the fourteen districts in Loei province were purposively selected as they have been designated key sustainable tourist destinations by the provincial development agency [23]. They represent a range of terrains (highlands, plains, river basin areas) and local cultures, and are named: Na-Haew, Dan Sai, Phu Rua, Tha Li, Chiangkhan, Muang Loei (city district of Loei province), Phu Kradueng, Nong Hin, and Phu Luang. One subdistrict was then randomly selected from each of these nine districts. All the villages within each of the nine selected subdistricts were the study sites.

Figure 1. Loei province (✸), north-eastern Thailand (Source: CartoGIS Services, College of Asia and the Pacific, The Australian National University; CC BY SA).

2.2. Data Collectors

The principal investigator (first and joint-corresponding author) recruited three research assistants who were educated to a bachelor's degree level (Major in Food and Nutrition). All were experienced in collecting food data and were native to Loei province. The research assistants were trained together on the administration of a semi-structured questionnaire, focus group guideline, and transcription of focus group discussion before the start of data collection. The principal investigator was responsible for overseeing the training of the research assistants and shadowed them during the first week of each phase of data collection and then on random occasions over the course of data collection.

2.3. Participants and Data Collection

Data were collected over five months, including during rainy season.

2.3.1. Semi-Structured Interviews

The purpose of the first phase of data collection was to investigate the variety of local food and food preparation methods (research objective 1).

The researchers collaborated with each village leader to identify householders who were known to have rich local culinary experience and who took primary responsibility for preparing household meals. The researchers contacted each of the identified householders to set the time and location to provide further information about the study, obtain their permission to participate in the study, and conduct the interview. Respondents who met the following inclusion criteria were interviewed: a minimum of 10 years food preparation experience, willingness to share their food knowledge, and permanent residents of their village.

Some of the interviews were conducted in the village leader's house and others were conducted in the participant's house or in the village temple. Each interviewee was invited to share their knowledge of local foods and food preparation methods, and each interview lasted approximately 60 min. The interview was conducted using a semi-structured questionnaire. This was developed by the researchers to elicit information about habitual food consumption, ingredients, and food preparation including cooking methods. Each section of this questionnaire was further subdivided. For example, under food consumption, more detailed responses were elicited about curries, salads, etc. Information was obtained about the ingredients of the food mentioned and their food preparation techniques. Some data were confirmed by observing interviewee's commonly consumed food at their house. The interviewers sought any missing information for ingredients and preparation methods from the participants.

There were 423 interviewees (5–6 participants per village), representing all villages in each of the nine subdistricts. All potential interviewees were initially identified and approached with the assistance of a village leader, and all those who were invited were willing to participate in the interviews and consented to do so. Participants responded positively to the researcher's questions and engaged in discussion. Data collection ceased when information saturation had been reached.

2.3.2. Focus Group Discussions

In the second phase, for each subdistrict, a subset of 10 participants from different villages was invited to take part in a focus group discussion in a village leader's home or local temple. Village leaders assisted with organising the focus groups, and the informants freely engaged in the focus group discussions. Each focus group participant had previously been interviewed (described under Section 2.3.1) and was invited to join a focus group discussion on the pretext of their particularly rich knowledge and experience of local food and methods of preparing it. Two to three academic and nutrition experts were facilitators in each focus group, and research assistants transcribed the discussions. We

conducted a total of nine focus group discussions (one in each of the nine subdistricts), each with 10 participants, giving a total of 90 focus group participants.

A semi-structured focus group question guideline was developed based on the analysed results of the first phase of the study. This question guideline was designed to help the focus group facilitators initiate discussion on participants' ideas on the following main themes: how to increase the nutritional value, social value, and economic value of local food in Loei province (research objective 2).

2.4. Construction of a Local Food Database

Finally, a local food database was developed to catalogue and conserve the local food wisdom of Loei province (research objective 3). A total of three stakeholder groups were directly involved in its development. The first group consisted of software analysts (n = 3) who had expertise in computer science or related fields. The second group was composed of customer demand analysts (n = 12), which included local food experts from Loei province, experts in software analysis, researchers, and research assistants. The third group was the user group (n = 12), which included local residents of Loei province, computer experts, researchers, and research assistants.

Software designers used Adobe Dreamweaver, PHPMyAdmin, and AppServe for the development of the database, together with PHP, HTML, JavaScript, and SQL. The process and method of the research operation was divided into five phases according to the software production process model as follows:

1. Stage 1. Project Planning: This involved the first stakeholder group (software analysts; n = 3), who conducted meetings to plan database development. The feasibility of the database development schedule was studied before establishing a team (recruitment of assistant software analysts) and constructing the database according to the plan;
2. Stage 2. Analysis: The software analysts evaluated other databases and studied user needs (what information they would like to see) and usage issues to guide program design. The system development life cycle (SDLC) was used to guide this process;
3. Stage 3. Design: The software team designed a prototype database system. This consisted of a database, output, input, and user interface. Potential users (n = 12) then tried out the prototype; they included local people of Loei province, computer experts, researchers, and research assistants. The software team adjusted the database system in response to their feedback;
4. Stage 4. Implementation: The software team implemented the database system on android operating systems and tested its performance before installing it and conducting sessions with users. The system was set, and the team compiled a user manual, trained the users, then assessed the database. Any problems encountered were solved;
5. Stage 5. Maintenance: New features were added to the system, and support was provided to user tasks together with system maintenance.

2.5. Data Analysis

As there were several interviewers, and data were collected in different places (homes, temple, etc.) and at various times, investigator triangulation and environmental triangulation were used to check data validity [24,25].

Data obtained from the semi-structured interviews, in the first phase, were analysed and categorised according to content structure, based on the content analysis technique [26]. To address research objective 1 (investigate the variety of local food and food preparation methods in Loei province, Thailand), coding centred around the following six themes: recipe category, main fish and meat sources, main vegetable sources, aromatics and flavour-enhancing ingredients (herbs, seasonings, etc.), food preparation methods, and common dishes. Within recipe category, food was grouped as: (1) soup and curry; (2)

dip; (3) ingredients wrapped and cooked in banana leaf; (4) pounded recipe; (5) spicy salad recipe; (6) grilled recipe; (7) miscellaneous recipe. Foods were placed in the miscellaneous category if there were few recipes to form an independent category and the recipe could not be classified under any of the major categories.

In the second phase, focus group discussions set out to explore ways of increasing the nutritional, social, and economic value of the local food (research objective 2). Data that were transcribed during the focus group discussions were also analysed and categorised according to content structure, based on the content analysis technique [26]. To address research objective 2, data were coded around the following themes: improving nutritional value (ingredients, food preparation), social value (communal food preparation and eating behaviours), and economic value (food presentation and packaging).

Participant characteristics were presented using descriptive statistics.

2.6. Ethical Considerations

The study received ethical clearance from the Ethics Committee of Loei Rajabhat University Ethics Committee, Thailand (reference number: 016/2561; 25 June 2018), and was conducted in accordance with the Declaration of Helsinki.

3. Results

3.1. Participant Characteristics

Most participants were female (97%) and married (76%). Around 57% had received formal education up to primary school level and 32% up to secondary school level. Almost two thirds of the participants were farmers (63%) and most earned between 3001 and 9000 Thai Baht (approximately 84.5–253.5 USD) per month (Table 1).

Table 1. Characteristics of participants (*n* = 423).

Characteristics	
Age, mean ± SD years (min-max)	48.2 ± 8.4 (29.0–69.0)
Sex, *n* (%)	
Female	413 (97.6)
Male	10 (2.4)
Marital status, *n* (%)	
Single	25 (5.9)
Married/de facto relationship	324 (76.6)
Divorce/separated/widowed	74 (17.5)
Education level, *n* (%)	
No formal education	39 (9.2)
Primary school	243 (57.5)
Secondary school	138 (32.6)
College and above	3 (0.7)
Occupation, *n* (%)	
Housewife	32 (7.6)
Self-employed	71 (16.8)
Merchant	39 (9.2)
Farmer	269 (63.6)
Government officer	5 (1.2)
Other	7 (1.6)
Monthly income (Thai Baht), *n* (%)	
≤3000	39 (9.2)
3001–6000	243 (57.5)
6001–9000	138 (32.6)
>9000	3 (0.7)

3.2. Variety of Local Food and Food Preparation Methods

A total of 240 recipes were reported and documented. These were classified into seven categories. Table 2 shows the most commonly reported dishes within each category. The dishes were mostly eaten with sticky rice. Reported preparation methods included boiling, steaming, grilling, roasting, pickling, fermenting, pounding, grinding, and shredding.

By far the most reported recipe types were soups and curries, which accounted for 113 of the documented recipes (Tables 2–4). Soaked ground sticky rice was used as a thickening agent in one type of curry, known locally and "ohm", for example, mussel curry (ohm hoi) and chicken curry (ohm kai). Most were vegetable soups and curries, followed by fish soups and curries. In terms of their reported distribution, the most commonly reported types of curries and soups were bamboo shoot curries and cassia (*Senna siamea*) leaf curries, followed by mushroom curries, fish soups, mussel curries, chicken curries, and chicken soups. Respondents in all nine subdistricts reported consuming these types of curries and soups. As is typical in Loei province, none of the curries contained coconut milk.

Table 2. Food preparation techniques and commonly reported recipes in each category.

Recipe Category	*n*	Preparation Methods	Common Types
1. Soup and curry	113	Boiling (in water without coconut milk)	Bamboo curry (kaeng nor mai); Cassia leaf curry (kaeng khee lek); Mushroom curry (kaeng hed); Snakefish-/catfish-/mackeral-/tilipia-soup (tom pla); Mussel curry (ohm hoi); Chicken soup (tom kai); Chicken curry (ohm kai)
2. Dip	40	Grilling, boiling, grinding	Mackerel dip (jaew pla tu); Fermented fish chili dip (jaew pla la); Catfish chili dip (jaew pla duk); Tilapia chili dip (jaew pla nin); Snakehead fish chili dip (jaew pla chon); Climbing perch chili dip (jaew pla kheng); Chili dip containing fermented sathorn leaf extract (jaew dam)
3. Ingredients wrapped and cooked in banana leaf	23	Steaming, grilling	Bamboo shoot steamed in banana leaf (mok nor mai); Fish grilled in banana leaf (mok pla)
4. Pounded	17	Boiling, pounding	Bamboo shoot (sup nor mai); Mushroom (sup hed); Round Thai eggplant (sup makuar); Banana blossom (sup plee); Young jack fruit (sup khanoon)
5. Spicy salad	18	Raw or cooked (boiling, grilling) main ingredient mixed with herbs, chili, roasted ground rice	Spicy broken bone fruit salad (koi peka); Spicy bamboo shoot salad (koi nor mai); Spicy mushroom salad (koi hed); Spicy banana blossom salad (koi plee); Spicy fish salad (larb pla); Spicy shellfish salad (koi hoi); Spicy chicken salad (larb kai); Spicy water silk salad (larb tao)
6. Grilled	4	Grilling	Grilled chicken (kai ping); Grilled swamp barb (pla ping); Grilled mushroom (hed ping); Grilled buffalo skin (nang kwai jee)
7. Miscellaneous	25	Steaming, roasting, fermenting, pickling, shredding	Steamed fish (pla neung); Pickled fish (pla som); Chicken roasted in bamboo stem (kai larm)
Total number	240		

English name (transliterated local name).

Table 3. Reported types of fish, meat, amphibian, crustacean, insect and vegetables in recipes.

Recipe Category	Fish/Meat/Amphibian/Crustacean/Insect	Vegetables
1. Soup and curry	Catfish, Snakehead fish; Tilapia fish; Swamp barb; Java barb; Spring eel; Goldfin tinfoil barb; Sutchi catfish; Minnow fish; Mackerel; Siamese glassfish; Fish roe; Freshwater mussel, scallop, clam, and shrimp; Rice field crab; Snail; Frog; Tadpole; Pork (meat, skin); Chicken (neck, thigh, breast, wing, offal); Buffalo skin; Beef	Banana blossom; Mushroom; Taro stem (*Colocasia esculenta* (L.) *Schott*); Climbing wattle (*Acacia pennata*); Lotus stalk; Banana stalk; Bamboo shoot (*Thyrsostachys siamensis*); Palm shoot (*Arenga pinnata*); Sweet leaf bush (*Sauropus androgynus*); Pumpkin; Young jackfruit; Cassia leaves (*Senna Siamea*); Horseradish; Vegetable Hummingbird flowers (*Sesbania grandiflora*); Water silk (*Spirogyra*); Sponge gourd; Ceylon spinach (*Basella alba* L.)
2. Dip	Mackerel; Catfish; Tilapia; Snakehead fish; Climbing Perch (*Anabas testudineus*); Fermented fish; Freshwater crab and shrimp; Frog; Giant water bug (*Lethocerus indicus*); Dragonfly nymph; Cricket; Sparrow	Mushroom; round Thai eggplant; Bamboo shoot (*Thyrsostachys siamensis*); Rattan; Star apple
3. Ingredients wrapped and cooked in banana leaf	Minnow fish; Snakehead fish; Tilapia fish; Swamp barb; Small scale mud carp; Fermented fish; Fish roe; Rice field crab; Frog; Tadpole; Cricket	Banana blossom; Pumpkin flower; Mushroom; Senna leaves; Vegetable Hummingbird flowers (*Sesbania grandiflora*)
4.Pounded	Pork skin; Buffalo skin; Scallop	Mushroom; Bamboo shoot (*Thyrsostachys siamensis*); Round Thai eggplant; Snake bean; Banana blossom; Unripe jack fruit; Vegetable fern; Climbing wattle (*Acacia pennata*); Vegetable Hummingbird flowers (*Sesbania grandiflora*)
5.Spicy salad	Fish; Scallop; Clam; Snail; Chicken	Broken bone fruit; Bamboo (*Thyrsostachys siamensis*) shoot; Mushroom; Water silk (*Spirogyra*); Banana blossom; Round Thai eggplant; Hermit's waterlily (*Limnocharis flava*)
6. Grilled	Fish; Chicken; Buffalo skin	Mushroom
7.Miscellaneous	Fish; Chicken; Bull frog; Buffalo skin	Bamboo shoot (*Thyrsostachys siamensis*); Cantaloupe

Table 4. Reported aromatic and flavour-enhancing ingredients used in recipes.

Recipe Category	Aromatic and Flavour Enhancing Ingredients (Herbs, Seasonings, etc.)
1. Soup and curry	Shallot; Garlic; Spring onion; Chili; Lemongrass; Hairy basil leaves; Coriander; Dill; Kaffir lime leaves; Fish sauce; Sodium chloride; Fermented fish sauce; Monosodium glutamate
2. Dip	Roasted shallot; Roasted garlic; Spring onion; Roasted chili; Coriander; Saw-tooth coriander; Lime juice; Fish sauce; Fermented fish sauce; Sodium chloride; Monosodium glutamate
3. Ingredients wrapped and cooked in banana leaf	Shallot; Garlic; Spring onion; Chili; Lemongrass; Hairy basil leaves; Kaffir lime leaves; Fish sauce; Fermented fish sauce; Sodium chloride; Monosodium glutamate

4. Pounded	Shallot; Garlic; Spring onion; Chili; Sesame seed; Coriander; Saw-tooth coriander; Ginger; Galangal; Lemongrass; Kaffir lime leaves; Fish sauce; Fermented fish sauce; Sodium chloride; Monosodium glutamate
5. Spicy salad	Shallot; Garlic; Chili; Ground roasted sticky rice; Galangal; Lemongrass; Kaffir lime leaves; Fish sauce; Fermented fish sauce; Lime juice; Monosodium glutamate
6. Grilled	Sodium chloride
7. Miscellaneous	Shallot; Garlic; Chili; Galangal; Ginger leaves; Lemongrass; Kaffir lime leaves; Spring onion; Hairy basil leaves; Fish sauce; Fermented fish sauce; Sodium chloride; Monosodium glutamate

During the preparation of bamboo curries, it was standard practice for people to first prepare the bamboo shoot by boiling it with the liquid extract of squeezed yanang leaves (*Tiliacora triandra*) added to water. Other vegetables were added to the curry, along with onion, lemongrass, and chili. However, there was some variation in the ingredients used in soups and curries between the nine subdistricts. For instance, respondents reported adding the following vegetables to their bamboo shoot curries: ear mushrooms, pumpkin, climbing wattle (*Acacia pennata*), sponge gourd (*Luffa aegyptiaca*), square zucchini (*Luffa acutangula (Linn.) Roxb*.), ceylon spinach (*Basella alba Linn*.), okra (*Abelmoschus esculentus*), a wild mushroom known locally as khonkhaw mushroom (*Lentinus squarrosulus*) and grey oyster mushroom (*Pleurotus sajor-caju (Fr. Singers))*. Two participants mentioned:

> "My family like to cook kaeng nor mai [bamboo shoot curry]. It is a typical recipe in Phukradung subdistrict as there is a lot of bamboo in the national park. People here cook bamboo shoot with ear mushroom, pumpkin, okra, climbing wattle, and hairy basil leaf." [LP 42]

> "In Kokthong subdistrict, people like to add different types of mushroom to kaeng nor mai [bamboo shoot curry], such as khonkhaw mushroom and grey oyster mushroom." [LP08]

Another participant in Chiang kan subdistrict mentioned:

> "My family always add square zucchini and ceylon spinach to kaeng nor mai [bamboo shoot curry]." [LP12]

Dip recipes were the second most reported type of recipe (n = 40; Tables 2–4). Most types of chili dip were fish-based, followed by vegetable-based chili dips. Vegetables that were used in these dips included mushrooms, Thai eggplant (*Solanum mairei H. Lév*.), and rattan shoot (*Calimus tenuis*). We also recorded other chili dips which contained either frog, field crab (*Somanniathelphusa*), or giant water bug (*Lethocerus indicus*). These chili dips were mostly included in every meal as part of the habitual diet. Participants reported often consuming meals comprised of a chili dip with rice and vegetables. Fermented fish sauce was a common dip ingredient, however, in one subdistrict (Dan Sai subdistrict), liquid extract made from fermented sathorn leaves (*Milietta Utilis Dunn.*) was used as an alternative seasoning in dips:

> "Jaew dam [chili dip containing fermented sathorn leaf extract] is a very common dip in Dan Sai subdistrict. We pound roasted dried chili, onion and garlic, and add salt and extracted sathorn juice for seasoning." [LP22]

The next most reported recipes were those which involved steaming or grilling ingredients inside a folded banana leaf, known locally as "mok" (n = 23; Tables 2–4). One that was eaten in all nine subdistricts was bamboo shoot steamed in banana leaf. Bamboo shoot (first prepared with the liquid extract of squeezed yanang leaves (*Tiliacora triandra*)) is mixed with soaked and pounded sticky rice, onion, and chili. Other non-meat containing "mok" recipes are based on mushroom and cassia (*Senna siamea*) leaves. Another typical "mok" recipe is ground minnow fish grilled in banana leaf. Many subtypes of these recipes contain fish. Common seasonings in the steamed and grilled banana-leaf wrap recipes are sodium chloride, monosodium glutamate, and fermented fish sauce. Hairy

basil is also a typical ingredient, which is sometimes added to bamboo shoot steamed inside a banana leaf. One participant stated:

> "My family like to eat mok pla [fish grilled in banana leaf]. It is very easy to prepare and cook. I only mix minnow fish with salt, monosodium glutamate and hairy basil leaf. I then wrap it in a banana leaf and grill it for about 10 min." [LP39] Specific ingredients, namely kaffir lime leaf, lemongrass, galangal, and ginger, were used only in grilled banana leaf wrap recipes that contained either: spicy ground fish, fishroe, frog, tadpole, cricket, or pork.

We recorded 17 pounded recipes, known locally as "sup" (Tables 2–4). The most typical ones were made from bamboo shoot, fermented bamboo shoot, or round Thai eggplant. Other less common "sup" recipes contained either: unripe jackfruit, mushroom, snakebean, paco fern (*Diplazium esculentum*), or mixed vegetables. The main vegetable ingredient is first boiled or steamed then pounded with other ingredients such as toasted ground rice, sesame seeds, onion, garlic, and seasonings such as fermented fish sauce, fish sauce, monsodium glutamate, fresh chili, or ground dried chili. A participant stated:

> "Mushroom sup [pounded mushroom] is a dish that I like to cook. I boil ear mushroom and snakebean and pound these ingredients with roasted sesame seeds and chili powder. I season it with fish sauce, fermented fish sauce, and monosodium glutamate and serve it with spring onions on top." [LP44]

The 18 spicy salad recipes could be sub-grouped as either spicy-ground salad recipes or spicy-sliced salad recipes, known locally as "larb" and "goi", respectively. The former subtype is made from ground cooked pork, fish, chicken, scallop, snail, or clam, or raw shrimp (Tables 2–4). A raw and spicy-ground water silk (*Spirogyra*) salad (known as larb tao) contains pounded mackerel and is very typical of this recipe type in Loeiprovince. The main ground ingredients are mixed with ground roasted rice, onion, lime juice, chili, peppermint, and saw-tooth coriander. Fermented fish sauce, fish sauce, sodium chloride and monosodium glutamate are used as seasonings in these recipes:

> "People here like to cook larb tao [spicy-ground water silk salad] as we can get it [water silk] from the Khong [Mekong] river. I pound grilled mackerel and mix it with water silk, galangal, ground roasted rice, and season it with chili powder and fermented fish sauce and serve it with chopped spring onion and coriander." [LP18]

There were four grilled recipes: mainly chicken, fish, and buffalo skin (Tables 2–4). The chicken is simply salted before grilling, whereas oyster sauce, garlic and monosodium glutamate are added to fish and buffalo skin before they are grilled. Unseasoned grilled mushroom was also consumed. Participants commented that these grilled foods were quick and convenient to make. For instance, one participant mentioned:

> "My family likes to eat ping pla khaw [grilled swamp barb]. We usually get it from a swamp near our rice field. We can get it when we want to eat ping pla khaw. I just only add some salt and then grill it." [LP44]

There were 25 miscellaneous recipes. These were mainly eaten as side dishes or eaten alone (Tables 2–4). They included dishes which are locally named "miang" and are composed of different ingredients wrapped in a betel leaf (*Piper betel* L.), gooseberry leaf (*Phyllanthus acidus*), or young papaya leaf. They mainly contained herbs such as lemongrass, ginger, and galangal, in addition to round Thai eggplant (*Solanum mairei H. Lév.*), peanut, and chili, and were seasoned with fish sauce, sathorn liquid extract and salt.

Another item in this category was "larm" which is chopped chicken with a condiment composed of chili, galangal, lemongrass, onion, and garlic, mixed together and seasoned with fish sauce and salt, then grilled inside a bamboo stem.

A recipe known locally as "Sar" was also placed in this category. This consists of grated Thai cantaloupe, fermented fish sauce, fish sauce, monosodium glutamate and sugar. There were also pickled ("som") recipes, namely pickled pounded bamboo shoot

(som nor mai) and pickled pounded fish (som pla) mixed with steamed sticky rice and seasoned with garlic, salt, and monosodium glutamate, then enclosed in a banana leaf wrapping and left for 2–3 days before eating. Another recipe that was placed in the miscellaneous category included fermented rice noodle, along with a set jelly which is known locally as mor noi and is made from liquid extracted from soaked pressed velvet leaves (*Cissampelos Pareira* L.).

3.3. Ways to Increase the Value of Local Food

3.3.1. Nutritional Value

Participants recognised that using a variety of seasonal, fresh, but good value, ingredients was important. They reported that some prepared ingredients, such as ready-squeezed yanang leaves and chopped vegetables and herbs for cooking, and ready-made foods, were available from the open market in the community. The nutritional quality of these items was discussed, and it was acknowledged that the source of a food could determine its nutritional value. Some participants had their own kitchen gardens, albeit with relatively few varieties of edible plants, as one participant reflected:

> "Although I have my own garden, I still buy ingredients from the market as the variety of vegetables I grow in my garden is less than the variety available at the market. Sometimes I even buy prepared ingredients as it is convenient, and it saves money." [LP10]

Different food preparation techniques produce meals which are both appetising and nutritious. Respondents had cooking tips to make meals taste more delicious. One subdistrict is well known for one particular seasoning which is made from the fermented extract of sathorn leaves (*Milietta Utilis Dunn.*). This produces a salty-tasting condiment that is lower in sodium compared with other commonly used seasonings. As one participant stated:

> "In my hometown [Dan Sai subdistrict], most householders use sathorn sauce, naturally fermented plant juice, rather than fish sauce." [LP28]

Other focus group participants described how they adapted recipes according to the availability of ingredients, including seasonal availability, to retain taste and variety. This often maintained the nutritional value of a local dish. Typically, fresh fish was substituted for dried varieties:

> "People here normally cook banana blossom curry with either fresh catfish or snakehead fish. I sometimes cook it with dried squid or dried minced fish, if I cannot get fresh catfish or snakehead fish." [LP86]

Another participant mentioned:

> "I also cook banana blossom curry with scallops or clams depending on which are available." [LP38]

During rainy season, there are a lot of raw materials in the community, which exceed demand. As was evident from the focus group discussion, some community members still practise methods of preserving and processing food ingredients at home, to maintain their availability all year round:

> "In rainy season, my family collects a lot of bamboo shoot from the forest and we cannot eat them all. Therefore, we preserve the bamboo shoots by fermenting them." [LP4]

A different participant indicated that she followed the same practice:

> "Yes, me too. However, we cannot keep it [the fermented bamboo] for too long as it spoils." [LP41]

There were also other examples of food preservation:

> "Most people here like to get some frogs and bullfrogs at night after the rain as they come out to the ground. Some people sell them as there are a lot and some are grilled and dried to keep them for a longer time." [LP52]

Another focus group participant added:

> "It can be made in to fermented bullfrog too." [LP56]

Adding extra ingredients to a traditional local recipe was also practised, which increased the nutritional value of the recipe. Respondents recounted their utilisation of seasonal local vegetables that were easy to find in the community. These were added to a vegetable curry recipe, with the intention of either enhancing the curry's flavour while reducing the amount of monosodium glutamate needed or increasing its health value. For instance, one participant reported using Chinese violet (*Asystasia gangetica (L.) T. Anderson*) leaves, known locally as "oomsab":

> "I sometimes add some leaves called oomsab [Chinese violet] to a curry. It makes the curry naturally sweet and delicious. If we add these leaves, we do not need to add monosodium glutamate to our curry." [LP22]

Another participant expressed how she added varieties of mushroom to a bamboo curry, in the belief that it provided health benefits:

> "I like to have bamboo curry with different types of mushroom. They are good for the body." [LP4]

One participant described the addition of another local vegetable, ceylon spinach (*Basella alba* L.) to curry:

> "Some families add another vegetable in the curry such as plang [ceylon spinach]." [LP26]

Participants acknowledged the role that pesticides play in improving plant yield and quality, and mentioned that pesticides are often liberally applied to crops:

> "Recently, a lot of pesticides have been widely used in our community to increase plant quality and quantity" [LP1], "especially by the local people who grow vegetables for sale in the market." [LP2]

Participants also indicated that some people used pesticides in their home gardens.

> "Even if I do not use chemical pesticides in my kitchen garden, my neighbour uses chemical pesticides. These could contaminate my home-grown vegetables anyway." [LP3]

However, some suggested that community leaders could potentially play a role in promoting and supporting the cultivation of home gardens, rice fields, or other places without chemical fertilisers or pesticides.

3.3.2. Social Value

Sharing responsibility for meal preparation with family members is a way of strengthening family bonds and relationships. This promotes family interactions and passes on food knowledge and skills to children, helping to conserve local food culture. However, these days the participants were mainly solely responsible for the preparation of food for the family. As one participant stated:

> "I'm usually the one that's mainly responsible for family cooking." [LP4]

Some ingredients were purchased from the market in the community. Families also purchased ready-cooked food from markets as indicated in the following quote:

> "In the former days, we mostly cooked at home. Recently, I sometimes buy cooked meals from the local market on my lazy days as it is quicker and easier." [LP15]

Although it was relatively uncommon, a few participants indicated that modern technology has also replaced human hands to a certain extent. For instance, a few participants used an electric blender to grind soaked sticky rice, for greater convenience and speed:

> "I sell side dishes in my community. I usually use a blender to grind soaked sticky rice as I can make it quicker with a larger amount." [LP38].

Participants indicated that the traditional ways of life are not as common as they were in the past:

> "Nowadays, young people are more likely to work in the city, making the local north-eastern way of life, where relatives normally eat together, not as strong as it used to be." [LP2]

Nevertheless, the participants recognised that eating communal meals with family members and communal eating with neighbours at festival times and other public holidays increases social interaction and can help to preserve local food knowledge and practices. This is because these events commonly involve different family members and neighbours in the community getting together to prepare and eat meals, as mentioned in the following quote:

> "On a local community event day, most people in our village help each other for cooking and we have meals in the event area." [LP14]

3.3.3. Economic Value

Some of the focus group participants cooked local food dishes for sale within their communities. One participant stated that she made a small income from doing this:

> "Yes, I do [sell local food]. I cook some local dishes such as larb moo (spicy minced pork salad), papaya salad, some curry, and so on. I don't earn much money as my shop is small and I can't sell it at a higher price." [LP74]

Making food containers from locally grown biodegradable materials, such as the pseudostems of banana, betel palm, and bamboo, is also a means of increasing the value of food made for sale. This may have a potential positive impact on the environment, as discussed by the focus groups in Dan Sai and Chiangkan subdistricts. However, participants expressed concern that utilising these types of containers would be associated with higher costs, and people from the local community may not be able to afford that. For example, a participant said:

> "Some restaurants here use betel palm container for serving food, but the cost is high and local people can't invest in that." [LP52]

Other participants cooked food for sale, specifically with customers from the local community in mind. They suggested that people from outside the community would instead prefer to buy food from a larger restaurant which puts greater emphasis on the aesthetics or appearance of the food. For instance, as one participant said:

> "Most customers are local people. If they were tourists, they would go to a big restaurant with a more attractively presented food menu set for them." [LP72]

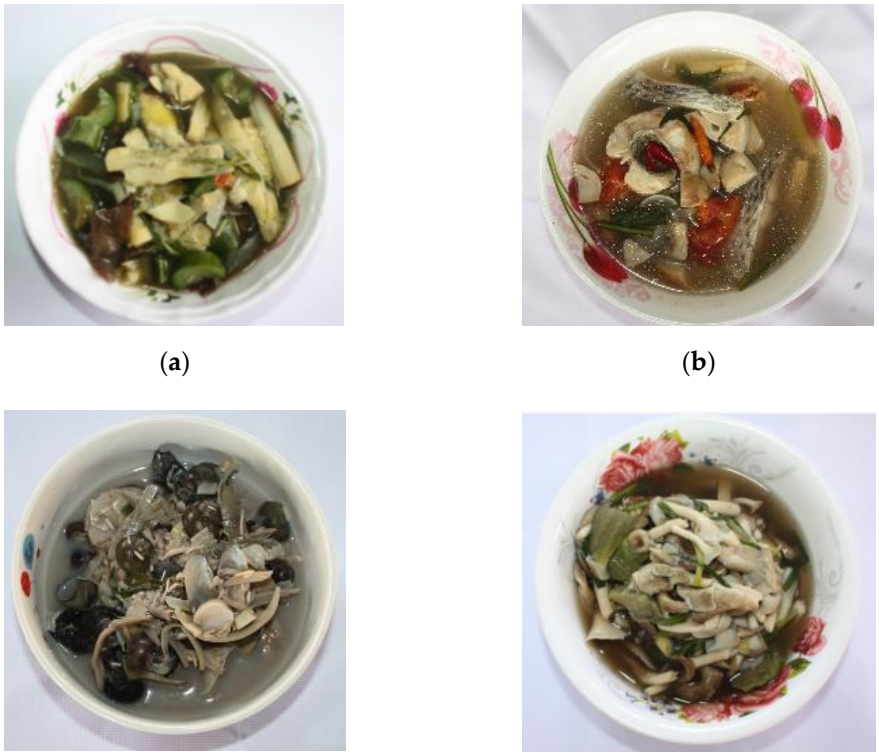
Nevertheless, participants acknowledged the potential aesthetic value of the local food dishes. For instance, a participant remarked:

> "I've been to Chiangkan walking street market. The food on sale there are very appetising as they are colourful." [LP25]

There is an abundance of vegetables, herbs, and fruits, which can be used to decorate or garnish dishes. Taking advantage of the diverse varieties and colours of the local edible plants, to decorate local dishes, is one way of enhancing their attractiveness and making them look more appetising. For instance, using local vegetables as decorations for chili dips. This could also increase the monetary value of foods, as food sellers could charge a slightly higher price for their decorated produce.

3.4. Local Food Database

Finally, we constructed a database of local foods, to catalogue and conserve the local food wisdom of Loei province (http://www.khamaon.com/loeifood/ (accessed on 7 April 2022)). The database is an account of all the dishes that were documented during this research, and it shows the names of each dish together with a photograph. Figures 2–7 show four common examples from six of the seven recipe categories: (1) curries and soups, (2) dips, (3) ingredients wrapped and cooked in banana leaf, (4) pounded recipes, (5) spicy salads, and (6) dishes that were classified as miscellaneous.



(**a**) (**b**)

(**c**) (**d**)

Figure 2. Examples of commonly consumed curries in Loei province, Thailand: (**a**) bamboo curry (gaeng nor mai); (**b**) fish curry (gaeng pla nin); (**c**) banana blossom curry (gaeng pli); (**d**) khonkao mushroom (*Lentinus squarrosulus*) curry (gaeng hed).

(**a**) (**b**)

(**c**)

(**d**)

Figure 3. Examples of commonly consumed dips in Loei province, Thailand: (**a**) mackeral dip (jaew pla tu); (**b**) aubergine dip (jaew makua); (**c**) chili dip containing fermented sathorn leaf extract (jaew dam); (**d**) frog dip (jaew gob).

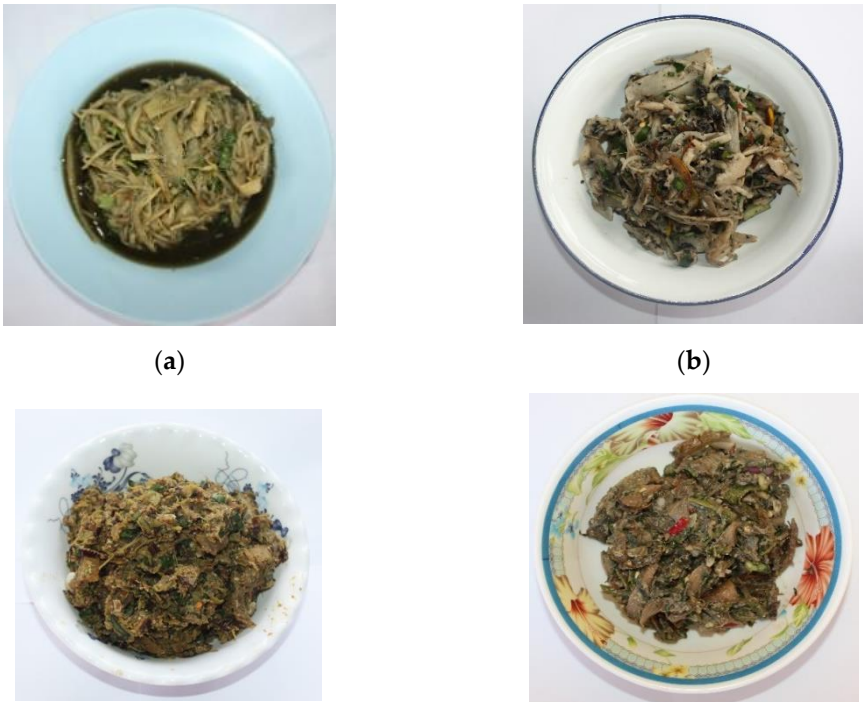
(**a**)

(**b**)

(**c**)

(**d**)

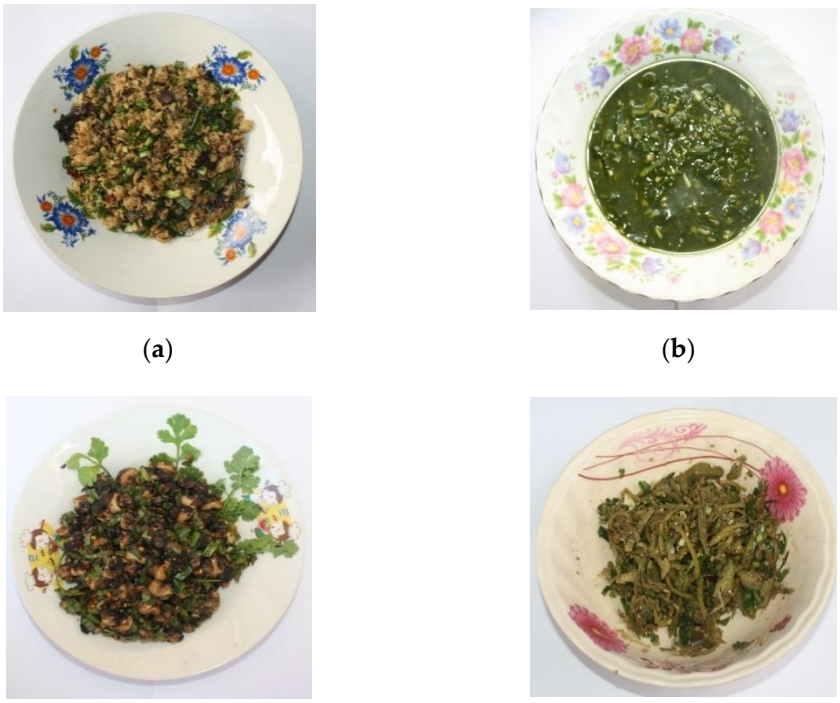
Figure 4. Examples of commonly consumed ingredients that are wrapped and cooked in banana leaf in Loei province, Thailand: (**a**) minnow fish (mok pla sil); (**b**) spicy small scale mud carp (mok larb pla nun jan); (**c**) cassia leaf (mok keelek); (**d**) snakefish (mok pla khor).



(**a**) (**b**)

(**c**) (**d**)

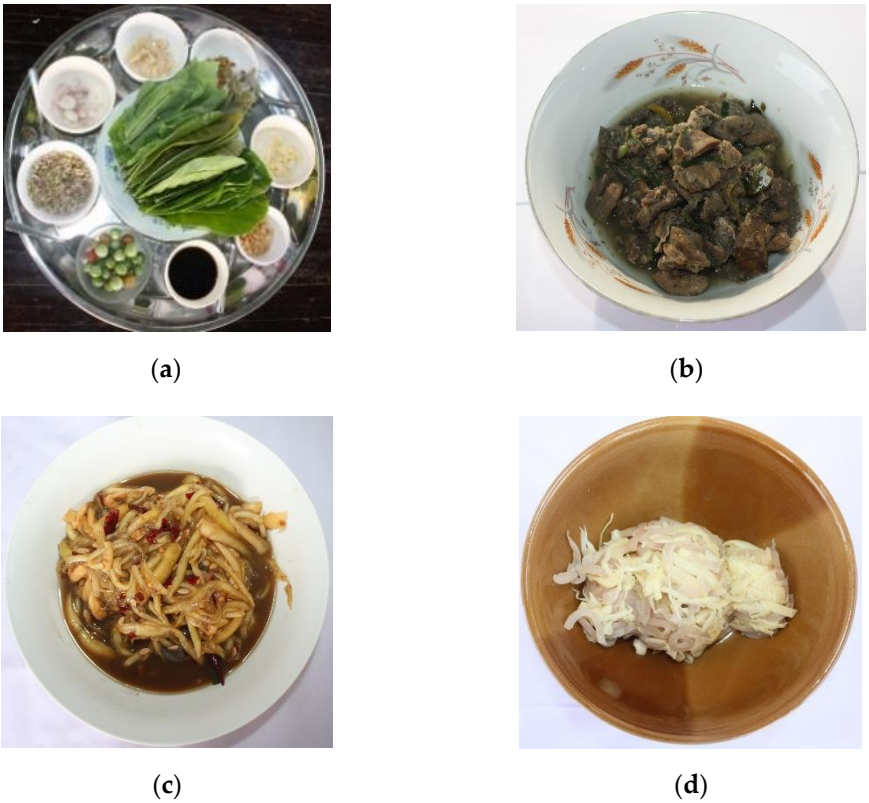
Figure 5. Examples of commonly consumed pounded dishes in Loei province, Thailand: (**a**) pounded bamboo shoot (sup nor mai); (**b**) pounded fermented bamboo shoot (sup nor mai dong); (**c**) pounded snakebean (sup tuer fak yaew); (**d**) pounded wild mushroom (Lentinus polychrous Lev.) (sup hed).



(**a**) (**b**)

(**c**) (**d**)

Figure 6. Examples of commonly consumed spicy salads in Loei province, Thailand: (**a**) spicy catfish salad (larb pla duk); (**b**) spicy-ground water silk salad (larb tao); (**c**) pond snail salad (goi hoi ju); (**d**) broken bone salad (goi peka).



(**a**) (**b**)

(**c**) (**d**)

Figure 7. Examples of commonly consumed dishes from the miscellaneous category in Loei province, Thailand: (**a**) ingredients wrapped in betel leaf (miang khon); (**b**) chicken with seasoning grilled in bamboo stem (larm kai); (**c**) grated raw Thai cantaloupe with seasoning (sar); (**d**) pickled bamboo shoot (som nor mai).

4. Discussion

4.1. Variety of Local Food and Food Preparation Methods

Our first objective was to investigate the variety of local food and food preparation methods which can be found in this upper-north-eastern province of Thailand. We documented a total of 240 dishes, which we placed into seven categories of recipe type. The dishes were mainly: (1) curries and soups, followed by (2) dips, (3) ingredients wrapped and cooked in banana leaf, (4) pounded recipes, and (5) spicy salad recipes. The preparation of most of the dishes mainly involved pounding ingredients using a wooden pestle and stone mortar, boiling and grilling, and fermenting and pickling, which are techniques that have been used for millennia [27,28]. The local recipes require relatively little cooking oil. Unlike in the central region, for example, where stir-fried dishes were assimilated into central-Thai food culture centuries ago [29], there is minimal use of frying in the preparation of the more traditional local dishes of Loei province. Similarly, we documented relatively few recipes that involved steaming (e.g., steamed fish "neung pla", bamboo shoot steamed in banana leaf "mok nor mai") which, along with stir-frying, is a cooking technique that was introduced to Thailand by the Chinese in the eighteenth century [30]. The regional cuisines of Thailand have developed from the amalgamation of food cultures, of the ancient kingdoms to which they once belonged, and more recently introduced food preparation methods and ingredients. Loei province was part of the Lan Xang Kingdom up to the early eighteenth century, and Dan Sai district was one of its principal towns [14]. Many of the characteristics of the local dishes of Loei province today remain closely connected to the history of this part of upper-north-eastern Thailand.

Our participants reported a widespread method of preparing bamboo shoot. This involved boiling bamboo shoot with the liquid extract of squeezed yanang leaves (*Tiliacora*

triandra) in water. It is an example of a common local practice which has been passed from one generation to the next. This preparation technique is practised in order to make the shoots taste less bitter. Bitterness is often associated with the presence of potential toxins. Indeed, it has been suggested that the liquid extract of boiled squeezed yanang leaves may remove certain toxins [31]. Other reported dishes were considered to be convenient or quick to prepare, such as: simply grilled foods, and grilled or steamed seasoned ingredients inside a folded banana leaf. This is noteworthy, as lack of time is sometimes cited as a major reason for not preparing food at home [32]. A number of traditional local foods consumed in Loei province, such as fish simply grilled in banana leaf with herbs and seasonings, do not involve time-consuming preparation.

Most of the recipes which we documented were curries and soups, and several of these were widely consumed in all nine subdistricts. This was also the case for the dishes in the remaining six categories. Similarities in the recipes reported between each of the nine subdistricts in Loei province might be due to their similar cultural influences. As summarised and discussed by Monterrosa et al. [33], personal drivers, including cultural norms and physiological and social conditioning, are significant predictors of food choice and dietary behaviours. The same authors also highlighted the role of environmental drivers of food choice and dietary behaviours, such as resources and food availability [33].

The dishes of Loei province reveal a close-knit relationship between the local community and the local environment's food resources. Bamboo shoot *(Thyrsostachys siamensis)* curries are ubiquitous in Loei province. Bamboo is a common collective term for many species of tall fast-growing woody grasses, which inhabit a diverse range of habitats from mountainous to lowland [34]. There was some variation in the ingredients used in the bamboo shoot curry recipes. Phu kradung subdistrict is a mountainous subdistrict in the southern part of Loei province, and the location of the Phu kradung national park. Our study participants there reported adding vegetables such as ear mushroom, pumpkin, okra (*Abelmoschus esculentus*), and climbing wattle (*Acacia pennata*) to their bamboo shoot curry. In contrast, participants who lived in Kok thong subdistrict and Chiang kan subdistrict (lower-lying areas) reported adding various other vegetables. Another example of variation was found with regards to seasoning. Residents in Dan Sai subdistrict preferred to use liquid extract made from fermented sathorn leaves (*Milietta Utilis Dunn.*) as a salty-tasting seasoning sauce instead of fish-based seasoning sauces. The terrain of Dan Sai is characterised by mountains, and there are fewer fish compared with the subdistricts that lie on the river plain. This may have given rise to the use of local wisdom to make full use of the local edible plants that are in the immediate area. Therefore, some of the variation in the ingredients used in dishes is likely to be partly attributable to the topographical diversity of the province. It demonstrates the resourceful of people and highlights the importance of preserving our local ecosystems.

The area has reasonable transport and communication links, together with many local commercial markets. Alongside this, some of the respondents indicated that they continued to utilise food sources from land and water close to their homes. Gathering wild foods and cultivating produce around the home reduces food purchasing costs and helps householders meet their dietary needs [35,36]. These practices are also connected to cultural traditions and norms, as wild foods remain part of the diet in many rural areas of Thailand [37–39]. Almost two thirds of our participants were farmers, meaning they had ready access to these resources. Both economic and cultural factors are key drivers of food selection [33]. In our study, gathered foods included those that were home-grown and those growing wild, close to the community, such as in rivers, canals, creeks, ponds, rice fields and other areas. These included fish, frog, field crab (*Somanniathelphusa*), and giant water bug (*Lethocerus indicus*). Water silk (*Spirogyra*), also commonly known as mermaid's tresses or blanket weed, was eaten in soups and curries and in spicy raw salads. It is a micro-alga which grows in free-flowing freshwater such as the Mekong River, and a common food ingredient in the areas of north-eastern Thailand which lie along the Mekong River and in neighbouring Lao PDR [39]. *Spirogyra* may have antioxidant properties [40].

In addition, its speculated prebiotic properties have been investigated, although other types of microalgae have been found to have much higher prebiotic potential [41].

Commonly used ingredients included fresh and dried chilies, shallots, spring onion, garlic, lemongrass, basil leaves, kaffir lime leaves, young galangal, key lime and tamarind. These herbal ingredients are typically grown by most householders, and are purported to have antioxidant, antibacterial, antihyperglycemic, and hypocholesterolemic properties [42,43]. In addition, the medicinal properties of many of the vegetables that are utilised in Loei local foods have been studied. For example, banana blossom is rich in dietary fibre and can reduce glucose diffusion in vitro [44]. Both banana blossom and pseudostem contain high amounts of polyphenols and antioxidants, which are associated with health benefits [45]. Similarly, cassia leaf (*Senna siamea*), an ingredient in a common curry, contains compounds which can reduce anxiety and exert a mild laxative effect [46].

We documented the utilisation of a rich variety of foods that grow in the surrounding environment, supporting local small-scale food producers and helping to maintain diversity in local food production. Some variation from one district to the next most likely reflects the province's diverse terrain, which ranges from mountain ranges to fertile plains [15,16]. Moreover, the traditionally prepared local food recipes of Loei province are generally high in phytonutrients associated with protection against the development of chronic disease.

4.2. Ways to Increase the Value of Local Food

Secondly, we investigated ways of increasing the nutritional, social, and economic value of local food in this province. Each aspect of local food value is discussed separately:

4.2.1. Nutritional Value

Important considerations with regards to ingredients were freshness, variety, and value for money. Respondents used their market purchases to supplement the ingredients taken or grown from around their home and to add variety. Ingredients were acquired very locally. People may perceive locally produced foods as fresher, and subsequently associate local ingredients with greater nutritional value. However, the evidence suggests that cultivation, processing, and storage practices are more important determinants of food quality, rather than the distance between the producer and consumer [47]. To benefit the local community who rely on locally grown food, it is therefore imperative for governments and the agroindustry to support farmers in the use of cultivation, processing, and storage techniques which help to maintain the nutritional value of local produce. Nutritional quality could also be enhanced by supporting people who are accustomed to growing their own edible produce via increasing access to different varieties, facilitating communal gardening in common areas for those who do not have their own land, and providing other incentives.

Participants recognised that applying pesticides improves crop yield and aesthetic quality. The agricultural sector in Thailand is heavily dependent on chemicals to control insects, weeds, and fungi [48]. The impact of the use of pesticides and chemical fertilisers on nutritional value remains contentious. The body of research evidence does not delineate any nutritional differences between organically produced and conventionally produced foods [49]. Many other factors seem to have a much more significant impact on the nutritional content of food produce, such as fertiliser program, soil type and health, plant/animal genetics, stage of maturity at harvest/slaughter, and season [49]. Nevertheless, chemical residues are frequently detected on food produce [50,51], thus potentially exposing the consumer to these contaminants. The health effect of occupational exposure to pesticides is also a widely acknowledged problem in Thailand [48]. In addition, excessively used chemical pesticide and fertiliser leach into waterways, where they have a detrimental effect on aquatic life [52]. This too is very significant, as the consumption of wild aquatic life is common. Minimising chemical contamination of food and the environment is therefore important, to improve food safety and protect wild food sources.

Some of our study participants reported purchasing specific ready-prepared ingredients and ready-to-eat foods from local markets. It has been previously reported that this is convenient, relatively cheap, and sometimes more economical than cooking everything from scratch at home [27,32]. Other participants made food specifically for sale in their local community. However, ready-to-eat foods purchased from local food sellers and foods eaten away from home are high-sodium food sources [53]. Increasing food sellers' awareness and skills in techniques to moderate the sodium content of made-to-order and ready-to-eat foods could play a role in improving the nutritional quality of ready-made commercially available local foods.

We reported examples of the continued application of local wisdom and resourcefulness, which positively benefit the nutritional value of local foods. Dan Sai subdistrict is well-known for its processing of sathorn leaves (*Milietta Utilis Dunn.*), which are gathered from the local vicinity and fermented to produce a salty-tasting alternative to fish sauce. Fermented sathorn sauce is known to contain less sodium than fish sauce and is high in organoleptic compounds and antioxidants [54,55]. As a result, this sauce can reduce the sodium content of a recipe, whilst still retaining its salty umami taste. Similarly, participants recounted using Chinese violet leaves (*Asystasia gangetica (*L.*) T. Anderson*), known locally as "oomsab", to reduce the need for adding monosodium glutamate to a dish. Almost three quarters of the dietary sodium in this area is derived from seasonings such as fish sauce and fermented fish [7]. Therefore, encouraging and supporting the wider application of these examples of local wisdom could further improve the nutritional value of local foods, and even assist in the reduction of dietary sodium intakes in the region and beyond.

Within the local community, there were also examples of home-preservation of food and the adaptation of recipes to suit the local availability of ingredients from one season to the next. Participants provided examples of using fermentation methods to preserve foods in the rainy season, when certain foods were available in great abundance. For instance, substituting fresh fish for dried fish and fermenting bamboo shoots and amphibians in the rainy season, when these foods are most abundant. Several different methods of food preservation are important (drying, salting, pickling, fermenting), giving rise to an array of products, which help to maintain food supply in rural areas [56]. Fermented and pickled products are traditionally regular components of a meal or seasoning in Thai cuisines [56]. Food preservation imparts distinctive organoleptic qualities [56]. Common Thai fermented foods also contain bioactive microbes, including probiotic bacteria [57]. Evidence of the continued use of these traditional techniques of home food preservation is encouraging. Maintenance of this local knowledge is important to provide nutritious foods all year round and supports the principles of sustainable living. We could improve the transfer of appropriate knowledge of food preservation and improve the technology used for home preservation within the local community. This could help to prolong the shelf-life and nutrient value of preserved foods and contribute to food security at the household level.

4.2.2. Social Value

Solely consuming food prepared and cooked within the home environment and regular communal eating with family members were not as common as they were in the past. In accordance with this, previous research indicated that the consumption of pre-made cooking ingredients and ready-to-eat foods from markets is now fairly common within the local community [7]. Economic development and social media influence the aspirations of people, especially the younger members of a community. The impact of globalisation on the nutrition transition is widely acknowledged. Dietary convergence is one outcome of globalisation, whereby consumers take advantage of increased access to foods from other countries [58]. Food globalisation is widely believed to affect food choice among younger generations in particular. University students in other countries may show a preference for food that is quickly prepared, packaged, and sold in non-formal

settings, rather than food made at home [59]. Around 50% of 15–19-year-old youths, who were from both urban and rural areas of three provinces in north-eastern Thailand, enjoyed eating western-style fast foods [60]. Nevertheless, almost half of the adolescents expressed a feeling of pride in their local traditional foods and considered them to be an important part of their local identity. Seubsman and colleagues [60] suggested that traditional local foods could be made more attractive for youths, by modifying packaging or presentation and by adjusting flavours to suit their palates. A more recent study of dietary habits among Thai adolescents suggested that the Theory of Planned Behaviour could be used to design interventions for promoting healthy eating among this population group [61]. Patcheep also recommended adopting programs that increase healthy food availability, accessibility, and self-efficacy [61]. These findings could be useful for planning strategies to promote consumption of local food and increase its social value among adolescents.

Some of our interviewees made use of labour-saving devices when preparing foods. A few householders used electric food processors and blenders in place of traditional methods of grinding and pounding ingredients. These were residents who prepared food in bulk for sale in their local community, so these devices drastically reduced food preparation time. In high-income contexts, urbanisation has contributed to the increase in preprocessed foods and a loss of knowledge about traditional foods [28]. In a Thai context, as younger generations migrate to urban centres, they less frequently engage in food preparation with older family members and become more reliant on ready-to-eat and made-to-order foods [27]. Therefore, there is also a risk that local traditional food preparation skills may be lost from one generation to the next. However, modern technology also has a potential role to play in preserving local food wisdom, in addition to the approaches discussed in the previous paragraph. Its use could help to increase the social value of local food, as labour-saving devices reduce meal preparation time, which could make local food preparation more appealing to younger generations who move away or commute to larger towns and cities to pursue education and employment opportunities.

Although daily communal eating may be less common, community gatherings are still an inherent part of the local culture. Communal eating with neighbouring friends in the village at festival times and public holidays was practised. On these occasions, different family members and neighbours in the community congregate to prepare and cook meals. These traditions strengthen cultural cohesion and community identity [62]. They also help to perpetuate the relevance and role of traditional local foods in the modern-day setting. For example, Lines et al. [63] reported that First Nation adolescents in north-western Canada acknowledged the importance of active engagement with elders who transfer their traditional knowledge and experience of living off the land. Photovoice activities, which include discussion centred around photos of traditional food and food systems, effectively engage youths in their traditional food systems and connectedness to local culture [64]. Workshops that are designed to enable communities to identify interventions which motivate adolescents, and improve dietary habits, health, and general well-being, can also be constructive [65]. In Loei province and elsewhere, similar approaches could be used to explore traditional food systems with local youth and actively engage them in local food practices. Doing so would promote knowledge transfer and the social value of local traditional food culture.

Beyond fostering general health and local food sustainability, traditional food has symbolic and spiritual importance [66]. The connection between food and cultural expressions of identity increases the significance of community participation in activities that involve local food. Engagement in such activities is a sign of the health and cohesiveness of a community. In our study setting, and throughout the region, food plays a role in numerous traditional practices, which include celebrations and religious rituals. For example, spicy minced pork salad is served during the house blessing ceremony in the north-eastern region, as this dish is associated with good luck. Fermented rice noodle is communally cooked for consumption during a religious festival in March which is known as

Boon Pha Wet. The long length of the noodle is thought to represent the longevity of the community and is believed to promote long-lasting relationships. Encouraging youth engagement in celebrations and rituals that include traditional food is another means of passing on its value from one generation to the next.

Native foods in Loei province, and in the north-eastern region of Thailand in general, are pivotal to local cultural identities. The region is made up of provinces that maintain their own customs and are culturally distinctive from the rest of the country. A large proportion of the Thai population resides in the north-eastern region and transient work-related migration to other regions, especially the central region, has facilitated the spread in popularity of traditional north-eastern foods. Dishes such as north-eastern style spicy salads are famous throughout Thailand and beyond. However, there are many variants of a single dish in terms of its ingredients, within a province and between provinces and regions. For example, some variations of a dish may include chopped meat rather than ground meat, in other provinces different herbs may be added to a dish, and fermented fish sauce may be substituted for fish sauce.

Within their native communities, traditional dishes are most popular and are consumed on a daily basis. Almost 80% of older adults in Loei province reported habitually consuming local foods [67]. In the study conducted in three different north-eastern provinces, one quarter of adolescents reported that something felt missing if they did not consume local foods [60]. Almost two thirds of these adolescents also thought that the popularity of local foods could deter an increase in the consumption of western-style fast foods [60]. Such findings are promising, as patterns of consumption of traditional foods reflect population demand. Maintained popularity will ensure that local foods are retained.

4.2.3. Economic Value

Selling home-produced local dishes was a source of income for a number of participants. Using vegetables, fruits, and herbs to decorate food for sale was recognised as one way of increasing its economic value, as some customers may be willing to pay slightly more for attractively presented food. In addition to (1) using locally produced ingredients and (2) taste and flavour, appealing presentation has been described as a third specific characteristic of Thai food [27]. Invariably, colours and graphics help to increase the value of a food because they enhance a consumer's sensory perceptions of the food [68]. The utilisation of local fresh produce to enrich the presentation of a dish has the double advantage of adding value to food, firstly by making it more visually appealing, and secondly, by improving its nutritional value. This simply involves adding extra vegetables, such as whole round eggplant, cucumber, and carrot to accompany a dish, or providing extra herbs which are added to or eaten alongside a dish. As this does not entail processing a food, the nutritional value of a dish is enhanced rather than being sacrificed. Food which is made more attractive by the addition of extra colourful fresh vegetables and is made-to-order retains its nutritional value, whilst being highly marketable. Therefore, this is one simple way of increasing both the economic and nutritional value of a local food product.

In addition, utilising local biodegradable and abundant materials, such as the pseudostems of banana, betel palm, and bamboo for the production of food containers or decorations has the potential to increase the value of food and reduce the use of plastic containers. The environmental aspects of plant-product-based food packaging have been previously highlighted. For instance, Ezudu et al. [69] reported that leaf material has numerous advantages for packaging traditional Nigerian foods, including environmental benefits. In addition, natural biodegradable materials that might otherwise be underutilised can be turned in to environmentally sustainable food packaging via specialist manufacturing processes. An example is biodegradable film, which is made from agroindustrial waste products and can improve food safety [70] along with other biopolymer-based materials [71]. These are more advanced technology-dependent ways of diversifying products made from biodegradable locally available resources. Inevitably, their feasibility is dependent on investment and support from academia, governmental, and private sectors.

Geographical Indications are used in many countries to show the connection between a product and its place of origin. In Thailand, One Tambon (subdistrict) One Product (OTOP) products are widespread and well recognised. These products are a result of the OTOP program which aims to encourage a local entrepreneur in each subdistrict to produce a unique locally made product [72]. Produce is selected and formally branded as an OTOP product, based on its quality and export potential. Examples of OTOP food items in Loei province include produce made from fermented sathorn leaves (*Milietta Utilis Dunn.*) from Dan Sai district, namely fermented sathorn chili dips and fermented sathorn sauces [73]. Such branding serves to provide a platform for product promotion and can help to improve the economic value of a product.

Our group discussions highlighted the role that tourists can play in bolstering the economic value of local food wisdom. Promoting domestic tourism in particular has been a prominent part of government policy in recent years [23]. The subdistricts included in this study incorporate a rich diversity of terrains and local cultures, which bring intra-provincial variations in local food recipes. Gastronomy activities and events that are aimed at tourists often set out to raise awareness about local history and food culture, provide exposure to the local food environment, deliver a tasting experience [74], provide tourist set menus in homestay environments [75], or engage tourists in cookery courses [76]. All of these activities can generate employment opportunities, create cohesion within a local community, and boost the social value of the traditional food heritage.

4.3. Limitations and Strengths

Our interviews and focus group discussions were centred around commonly consumed foods, but some items may have been missed. However, our study included all villages within each of the nine subdistricts, and our informants were highly experienced cooks. Indeed, we collaborated closely with village leaders who were best able to identify the villagers who were most experienced and knowledgeable about the local traditional cuisine. Secondly, our data were collected over a five-month period, which included rainy season. Rainy season is a period of abundance when foods are preserved for the remaining two seasons. Many foods that are prepared and preserved in rainy season are consumed at other times of the year. Additionally, seasonal changes and adaptations to recipes were discussed during the focus group discussions. Consequently, the data we collected can represent foods commonly consumed throughout the whole year. Moreover, all of the data collectors were fluent in the local dialect and were familiar with the local foods, thereby improving the accuracy of data collection. To the best of our knowledge, this is the first study which has covered a large area of Loei province. We included the nine districts that have good access and are designated areas of special interest, especially with regards to ecological diversity, history, and tourism.

5. Conclusions

We documented a total of 240 dishes, mostly prepared using traditional techniques. Locally available ingredients were widely utilised and adapted according to seasonal availability. Many of the characteristics of the local dishes of Loei province today remain closely connected to the history of this area of Thailand and share close culinary ties with parts of nearby Laos PDR. The nutritional, social and economic value of local foods could be bolstered via various means including: improving the technology used for home preservation within the local community, actively engaging younger generations to improve the transfer of appropriate knowledge of food preservation and other traditional food practices, securing backing to invest in technology to make full use of local biodegradable materials, and tourist activities that are centred around local food heritage.

Future work will involve further development of the local food database. This will entail improving the presentation of the database, adding recipe details, and developing multi-lingual versions. Further research will also involve analysis of the nutrient composition of the recipes in the local food database, and the collection of information regarding

desserts. Importantly, studies should be conducted to test the feasibility and effectiveness of the application of the database by academics and local government officials, including schoolteachers, who are responsible for cookery classes.

Enhancing and conserving local food wisdom has the potential to promote food security, combat malnutrition, and benefit local farmers and the local economy, in line with sustainable development goals. Moreover, this research can serve as a model for the development of strategies to retain and value local food wisdom in other provinces, regions, and countries.

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