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# Diversity of Indonesian offal-based dishes

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## Abstract

Indonesia is a home to diverse ethnicities and cultures that have influenced its culinary tradition. Moreover, Indonesian culinary tradition is shaped by the country's wealth of natural resources, one of which is offal (including tripe, lung, intestine, liver, and so on). The utilization of offal has created myriad recipes of offal-based dishes (OBDs), resulting in a culinary diversity across the nation. Therefore, this article aimed to identify and create a culinary profile of Indonesian OBDs based on geographical distribution. To strengthen this culinary profile, historical creations of Indonesian OBDs were also elucidated. For centuries, Indonesian OBDs have been shaped by several factors, such as natural resources, history, religio-cultural, and economic backgrounds. For instance, specialties such as *momoh* (braised offal) from Central Java and *pallubasa* (coconut milk-based offal soup) from South Sulawesi were developed due to religio-cultural and economic reasons, respectively. Although 139 Indonesian OBDs are widely distributed across 23 Indonesian provinces, the foods are mostly concentrated in West Sumatra (31 dishes), Central Java (18 dishes), and East Java (14 dishes). Furthermore, intestine, liver, and tripe are the most commonly used types of offal as utilized in over 40 dishes; while cattle, water buffalo, and chicken are the most utilized sources of offal. Meanwhile, pig offal is only used in the non-Muslim regions of Indonesia. The creation of Indonesian OBDs is also influenced by foreign cultures. For example, *gulai tambusu* (intestine curry) from West Sumatra, *rabeg* (Bantenese-styled mutton curry) from Banten, *babat gongso* (stir-fried cattle tripe) from Central Java, and the ubiquitous *sop buntut* (oxtail soup) demonstrate Indian, Arabian, Chinese, and colonial influences, respectively. However, OBD such as *saksang* (pork stewed in pig blood), which originated from Batak ethnic group, retains the native culinary features. Additionally, OBDs recipes involve several spices, herbs, and other ingredients that can maintain and improve their organoleptic attributes.

**Keywords** Diversity, Offal-based dishes, Offal, Indonesia, Ethnical identity, Culinary profile, Geographical distribution, History, Ethno-gastronomy

## Introduction

Indonesia is the largest archipelagic country in the world, with a megadiverse population and a wealth of natural resources [1]. It is located in a strategic position between two large continents (Asia and Australia) and two vast oceans (Pacific and Indian Oceans) [1]. Moreover, the country covers a total area of 7.81 million km<sup>2</sup> (which is about three quarters of the European continent), consisting of over 17,000 islands and inhabited by over 250 million people (i.e., about 3.5% of the world's population) from more than 1300 recognized ethnic groups [2]. This diversity is a remarkable potential source of power for the country, which is reflected in its national motto

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“*Bhinneka Tunggal Ika*,” (a phrase in Ancient Javanese that translates to “Unity in Diversity”) [2]. The diversity of Indonesian culinary tradition is also a national asset that reflects the wealth of its cultural heritage [3]. Over centuries, more than 5300 traditional dishes have been developed across Indonesia in the support of diverse natural, historical, cultural, and gastronomical backgrounds [3, 4].

One of Indonesia’s foremost natural resources is livestock. Animal husbandries are established across many regions in the country to fulfill the national demand for protein sources (such as meat, egg, milk, etc.). In 2020, the population of livestock in Indonesia was estimated to be over 400 million, consisting of cattle, water buffaloes, goats, sheep, pigs, chickens, ducks, geese, horses, and more [5]. Meanwhile in 2021, Indonesian animal husbandries had produced over 1.2 million tons of high-quality meats from different animals [5]. Another potential output of the animal production system is the variety of offal, which is considered a by-product. As the weight of offal is nearly half of the animal’s total weight, it is estimated that over 1.2 million tons of offal were produced by the Indonesian animal production system in 2021 [5, 6]. Thus, these abundant raw materials could be used as an affordable alternative source of protein.

Offal has long been used and incorporated into many Indonesian traditional dishes, which have historically been shaped by the country’s history, cultural background, and natural resources [3, 7]. Moreover, offal-based dishes (OBDs) have become an ethnic specialty in some Indonesian regions due to their uniqueness and authenticity [3, 7]. Initially, offal was considered a low-cost food ingredient [8]. As most Indonesian people were historically poor, they faced financial difficulties in affording the finest ingredients for their basic nutritional needs [8]. Therefore, offal became an affordable solution as a low-price source of protein for Indonesian families. However, a recent cultural shift has caused perceptions toward offal to change drastically, as it is currently considered a unique or even luxurious food [9, 10].

This literature review aimed to identify and establish a culinary profile of 139 Indonesian OBDs based on their geographical distribution, which was collected through several literature sources. In some Indonesian regions, OBDs creation is influenced by various histories, culinary traditions, economic and cultural backgrounds, which is also an aspect that was elucidated in this review. The recent development of Indonesian OBDs was also reviewed in this article. Furthermore, this culinary profile is the first study comprehensively reporting the diversity of Indonesian OBDs which are essential to enrich the national and international gastronomical databases that have not been studied before. Moreover, the article can

potentially be the future reference since providing any meritorious information for those working in the related studies (food science, ethno-culinary science, gastronomy and cultural science).

In general, the review article includes research backgrounds and methodology used in the study. Then, the article attempts to highlight the perspective of Indonesian OBDs from historical and cultural aspects and their regional distributions through a number of scientific discussions. The article also provides conclusive statements of study and also future recommendations.

## Methods

The manuscript is a literature review focusing on developing a culinary profile of Indonesian OBDs based on their geographical distribution, history, culinary tradition, economic and cultural backgrounds. Information related to Indonesian OBDs was collected from books, websites, academic journals, and online documents. Data from online sources were searched using keywords and Boolean expression logics, such as “Indonesian foods made of offal”, “Indonesian foods made of a particular type of offal” (for example: “Indonesian foods made of liver”), “offal-based foods from a particular Indonesian region” (for example: “offal-based foods from South Sulawesi”), “history of a particular Indonesian OBDs” (for example: “history of *pallubasa*”), “cultural/economic backgrounds behind the creation of a particular Indonesian OBDs” (for example: “cultural backgrounds of *momoh*”/“economic backgrounds behind the creation of *soto tangkar*”) and combination of those keywords. Meanwhile, data from offline sources were manually searched using similar principles as that of online sources. This article used offline and online literature sources from 1965 to 2023.

The data were collected, selected and grouped into categories as follow: names of dishes, geographical origins, sources of offal, types of offal, the use of offal in the dishes (main, secondary and alternative ingredients), recipes, and preparations of Indonesian OBDs. Other data related to historical, culinary tradition, economic and cultural backgrounds of Indonesian OBDs as well as other supporting information (including the recent development of Indonesian OBDs) were also collected to support the study. Data were processed using Microsoft Excel version 2016 and presented in figures, tables and pie diagrams.

To verify the data and strengthen the literature study, a number of mini-field observations and interviews were further conducted (Additional file. 3). The mini-observations and interviews were conducted in the city of Yogyakarta (Indonesia) which represents the multi-ethnicity of Indonesia as many ethnic-based food restaurants (including OBDs restaurant) have been established in the

city [2, 11, 12]. The interviewees were people working in the related areas (chefs, food entrepreneurs and gastro-nomic experts).

Books used in this study consist of cookbooks, recipe books, and other books (especially related to history, foods history, foods cultures and gastronomy). Information was also gathered from websites (especially related to recipes, history, cultural significance and also recent development of Indonesian OBDs). Meanwhile, online documents were reports, statistical data and religious laws that support the study. In terms of academic article, the articles were collected and selected from Q1 to Q2 (Scimago indexing) and SINTA 1–2 (Indonesian national journal indexing) journals for international journal and national journal, respectively. Meanwhile, other articles were collected from Crossref database due to accessibility and selectivity.

## Results and discussions

### The history and development of Indonesian offal-based dishes

According to the *Encyclopedia Britannica*, offal can be described as non-meat materials of a slaughtered animal, including brain, blood, heart, kidney, liver, spleen, lung, tripe, intestine, gizzard, trotters, skin, feet, and tongue [13]. In some cultures, the definition is further extended to include head skin, lip, bone, bone marrow, testicle, nipple, tendon, ovary, and more [6, 14]. In some cultures, offal is considered an impure food and a method of humiliation, while other cultures regard it as a delicacy [10, 14, 15].

Due to its strategic location, Indonesia has become a confluence of many cultures (such as Indian, Chinese, Arabian Islamic, Polynesian, colonial European, and indigenous cultures), which has enabled many instances of acculturation. This acculturation also impacts on the Indonesian culinary tradition, where numerous dishes (including OBDs) have been developed based on myriad recipes as a result of the acculturation of different cultures (including in the development of OBDs) [3].

In the first century BC, Indians arrived in maritime South East Asia for economic reasons and, according to historians, contributed to the spread of Indian religions and cultures in the area [16]. Indonesian inhabitants further adopted Indian religions in syncretization with local folk religions and animist beliefs. Notably, entire religious laws and liturgical activities have not been strictly adopted in Indonesia [16]. For example, Indonesians have rejected the stringent concept of caste, viewing caste (*varna*) as a functional group rather than a social hierarchy [16, 17]. This cultural adaptation has also affected Indonesia's dietary and culinary culture. In India, some adherents of Hinduism, especially those belonging to

higher castes such as *Brahmins* (priests and teachers) and *Kshatriyas* (administrators and warriors), follow a diet based on a strict principle of lacto-vegetarianism (only consuming dairy and vegetarian-based foods) [18]. According to the *Ahimsa* law (i.e., the principle of non-violence), animal slaughtering for daily consumption is considered inhumane [18]. Therefore, the daily consumption of meat and organs (offal) is only allowed for the middle caste (*Vaishyas*, for farmers and merchants) and the lower caste (*Shudras*, or laborers and slaves), respectively; since higher castes may not do the inhumane activity [18]. Additionally, in Hinduism, inner organs are considered impurities that can only be eaten by the lower caste [18]. However, this principle of lacto-vegetarianism has only loosely been adopted in Indonesian Hindu communities (only followed by limited sectarians of the *Brahmin* caste) [17, 19]. Meanwhile, the influence of South Indian curry can only be discovered in some places in Indonesia such as Sumatra, coastal Kalimantan, and parts of Sulawesi [3]. This is probably because this curry was only gastronomically acceptable by the people in those areas in the early period of India-Indonesia contact [20]. Interestingly, Indonesian curries are mostly made in a coconut milk basis, which is similar to the preparation of South Indian curries [20].

An example of curry-like dishes in Indonesia is the Minangkabau cuisine found on the island of Sumatra. It is claimed that the ancestors of *gulai* (a Minangkabau curry) and *kalio* (a spicy Minangkabau curry) were probably developed as far back as the eighth century utilizing non-*halal* and water buffalo meats [20]. However, the use of offal in the Sumatran curry has not been literally recorded. The Minangkabau people consider the water buffalo as a symbol of strength; therefore, the consumption of this meat is believed to empower people [21]. Moreover, the non-*halal* meats that were most probably utilized to prepare the ancient version of curry were pork, wild boar, dog, reptiles, and more, which are usually consumed by their Batakese counterparts who live in the hinterland of Sumatra [20]. In contrast, Batakese people tend to retain their Austronesian culinary tradition, which involves the use of animal blood and pork [22, 23]. The utilization of offal is discovered in some Batakese dishes, such as *saksang* (pork stewed in pig blood) (Fig. 1A) and *lomok-lomok* (Batakese pork and pig offal stew) (Table 1). In this context, offal is seen to play a pivotal function in strengthening the *tondi* (soul) [23]. The main characteristic of Batakese traditional cuisine is the use of pungent *andaliman* (*Zanthoxylum acanthopodium*), which has been in use long before the introduction of chili pepper (*Capsicum annum*) [22]. With the arrival of Islam in Sumatra in the thirteenth century (especially in Aceh as well as the eastern and



**Fig. 1** *Saksang* (pork stewed in pig blood) from North Sumatra (A); *gulai tambusu* (intestine curry) from West Sumatra (B); *lawar* (Balinese mixed vegetable with grated coconut flesh) from Bali, added with pig blood (C); *rujak cingur* (lip salad) from East Java (D). *momoh* (braised offal) from Central Java (E); *rabeg* (Bantenese-styled mutton curry) from Banten (F); *babat gongso* (stir-fried cattle tripe) from Central Java (G); *coto Makassar* (Makassar-styled beef soup) from South Sulawesi, also utilizing offal (H); The ubiquitous *bakso jeroan* (meatballs with offal topping) (I)

western coasts of Sumatra), *halal* meats began to be utilized in dishes, including curry [20, 21]. Consequently, offal of *halal* animals also began to be widely consumed since it is considered *halal* and its usage could avoid a food disposal (*mubadzir*) [24, 25]. Offal can be discovered in number of recipes of *gulai* and *kalio*, such as *gulai otak* (brain curry), *gulai tambusu* (intestine curry) (Fig. 1B), *kalio babat* (tripe spicy curry), and *kalio usus* (intestine spicy curry) (Table 1). As there is a tradition among Minangkabau people to wander outside their

hometown (*merantau*), a relatively preserved version of the spicy curry (*kalio*) was created in a drier basis, popularly known as *rendang* (dried spicy curry) [21]. Philosophically, the long duration involved in processing *rendang* is considered to be a symbol of patience [20]. The history of *rendang* creation has been well-documented in the *Hikayat Amir Hamzah* (from around the fifteenth century) [21]. Offal is also used in *rendang*, such as in *rendang hati* (dried liver spicy curry) and *rendang babat* (dried tripe spicy curry) (Table 1). In 2017, the

**Table 1** The Indonesian OBDs based on their origin, offal source, type of offal, and their utilization in the dish

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
1	Gulai Kambing Aceh	Aceh	Acehnese-styled Mutton Curry	Goat	Liver, tripe, intestine, lung, etc		✓		[27]
2	Saksang	North Sumatra	Pork Stewed in Pig Blood	Pig	Blood, intestine, bone		✓		[22]
3	Babi Panggang Karo	North Sumatra	Karonese-styled Grilled Pork	Pig	Intestine, liver, blood		✓		[22]
4	Chasio Medan	North Sumatra	Braised Pork	Pig	Skin, intestine, tripe, ears		✓		[28]
5	Lomok-lomok	North Sumatra	Batakese Pork and Pig Offal Stew	Pig	Intestine, tripe, skin		✓		[22]
6	Soto Medan	North Sumatra	Medan Soto (Soup)	Chicken	Liver, gizzard, intestine		✓		[29]
7	Kidu-Kidu	North Sumatra	Batakese-styled Pork Sausage	Pig	Intestine		✓		[22]
8	Manuk Napinadar	North Sumatra	Chicken Stewed in Blood	Chicken	Blood		✓		[22]
9	Gulai Telur Ikan	West Sumatra	Fish Ovary Curry	Fish	Ovary	✓			[30]
10	Rendang Hati	West Sumatra	Liver <i>Rendang</i> (Minangkabau Spicy Dried Curry)	Cattle, Water Buffalo	Liver	✓			[31]
11	Rendang Usus	West Sumatra	Intestine <i>Rendang</i>	Cattle, Water Buffalo	Intestine	✓			[31]
12	Rendang Paru	West Sumatra	Lung <i>Rendang</i>	Cattle, Water Buffalo	Lung	✓			[31]
13	Rendang Kikil	West Sumatra	Tendon and Head Skin <i>Rendang</i>	Cattle, Water Buffalo	Tendon, head skin	✓			[31]
14	Rendang Babat	West Sumatra	Tripe <i>Rendang</i>	Cattle, Water Buffalo	Tripe	✓			[31]
15	Nasi Goreng Padang	West Sumatra	Minangkabau-Styled Fried Rice	Cattle, Water Buffalo	Tripe, liver, intestine		✓		[32]
16	Gulai Otak	West Sumatra	Brain Curry	Cattle, Water Buffalo	Brain	✓			[30]
17	Gulai Babat	West Sumatra	Tripe Curry	Cattle, Water Buffalo	Tripe	✓			[30]
18	Gulai Usus/Tambusu	West Sumatra	Intestine Curry	Cattle, Water Buffalo	Intestine	✓			[30]
19	Gulai Tunjang	West Sumatra	Tendon and Head Skin Curry	Cattle, Water Buffalo	Tendon, head skin	✓			[30]
20	Gulai Sumsum	West Sumatra	Bone Marrow Curry	Cattle, Water Buffalo	Bone marrow	✓			[30]
21	Gulai Hati	West Sumatra	Liver Curry	Cattle, Water Buffalo	Liver	✓			[30]
22	Gulai Limpo	West Sumatra	Spleen Curry	Cattle, Water Buffalo	Spleen	✓			[30]
23	Gulai Cancang	West Sumatra	Mixed-Beef and Offal Curry	Cattle, Water Buffalo	Liver, tripe, intestine, lung, etc		✓		[30]
24	Gulai Paru	West Sumatra	Lung Curry	Cattle, Water Buffalo	Lung	✓			[30]

**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
25	Kalio Hati	West Sumatra	Liver <i>Kalio</i> (Minangkabau-styled Spicy Curry)	Cattle, Water Buffalo	Liver	✓			[33]
26	Kalio Usus	West Sumatra	Intestine <i>Kalio</i>	Cattle, Water Buffalo	Intestine	✓			[33]
27	Kalio Paru	West Sumatra	Lung <i>Kalio</i>	Cattle, Water Buffalo	Lung	✓			[33]
28	Kalio Babat	West Sumatra	Tripe <i>Kalio</i>	Cattle, Water Buffalo	Tripe	✓			[33]
29	Kalio Kikil	West Sumatra	Tendon and Head Skin <i>Kalio</i>	Cattle, Water Buffalo	Tendon, head skin	✓			[33]
30	Soto Padang	West Sumatra	Padang <i>Soto</i>	Cattle, Water Buffalo	Tripe, intestine		✓		[29]
31	Dendeng Paru	West Sumatra	Lung Jerky	Cattle, Water Buffalo	Lung	✓			[34]
32	Sate Padang	West Sumatra	Padang <i>Satay</i> (Grilled Meats on Skewer)	Cattle, Water Buffalo	Tripe		✓		[34]
33	Kerupuk Jangek	West Sumatra	Cattle Skin Chip	Cattle, Water Buffalo	Skin	✓			[34]
34	Balado Hati	West Sumatra	Liver <i>Balado</i> (Minangkabau-styled spicy stew)	Cattle, Water Buffalo	Liver	✓			[34]
35	Balado Usus	West Sumatra	Intestine <i>Balado</i>	Cattle, Water Buffalo	Intestine	✓			[34]
36	Balado Paru	West Sumatra	Lung <i>Balado</i>	Cattle, Water Buffalo	Lung	✓			[34]
37	Balado Babat	West Sumatra	Tripe <i>Balado</i>	Cattle, Water Buffalo	Tripe	✓			[34]
38	Balado Kikil	West Sumatra	Tendon and Head Skin <i>Balado</i>	Cattle, Water Buffalo	Tendon, head skin	✓			[34]
39	Sate Kulit	West Sumatra	Cattle Skin <i>Satay</i>	Cattle, Water Buffalo	Skin	✓			[34]
40	Keripik Telur Cumi	Bangka Belitung	Squid Ovary Chip	Squid	Ovary	✓			[35]
41	Songsui	Bangka Belitung	Bangka-styled Pig Offal Soup	Pig	Tripe, heart, intestine, liver, ears, etc	✓			[36]
42	Bak Kut Teh	Riau Islands	Riau Island-styled Pig Offal Soup	Pig	Bone, Bone Marrow	✓			[37]
43	Sop Tunjang	Riau	Tendon and Head Skin Soup	Cattle	Tendon, head skin	✓			[38]
44	Pindang Tulang Sapi	South Sumatra	Bone Marrow Soup	Cattle	Bone marrow	✓			[39]
45	Gulai Kembra'ang	Bengkulu	Kembra'ang Bone Curry	Cattle	Bone	✓			[40]
46	Rabeg	Banten	Bantenese-styled Mutton Curry	Sheep	Tripe, intestine, liver		✓		[41]
47	Angeun Lada	Banten	Bantenese-styled Spicy Beef Curry	Cattle	Tripe, intestine, liver, bone, heart, spleen		✓		[41]

**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
48	Sekba	Jakarta	Braised Pork and Pig Offal	Pig	Intestine, tripe, ears, skin		✓		[42]
49	Soto Betawi	Jakarta	Betawi <i>Soto</i>	Cattle	Intestine, tripe, liver		✓		[8]
50	Sop Kaki Kambing	Jakarta	Goat Trotter Soup	Goat	Trotters	✓			[8]
51	Soto Oseng	Jakarta	Stir-Fried <i>Soto</i>	Chicken	Liver, gizzard		✓		[8]
52	Soto Tangkar	Jakarta	Cattle bone and Trotter <i>Soto</i>	Cattle	Trotters, bone, bone marrow	✓			[8]
53	Empal Gentong	West Java	Cirebonese-styled Curry	Cattle, Water Buffalo	Liver, Tripe		✓		[29]
54	Soto Mi Bogor	West Java	Bogor Noodle <i>Soto</i>	Cattle	Intestine, tripe, liver, head skin	✓			[29]
55	Mi Kocok	West Java	Shaken Noodle	Cattle	Tendon, head skin		✓		[43]
56	Sate Terpedo	West Java	Penis <i>Satay</i>	Cattle, goat	Penis	✓			[43]
57	Piritan	West Java	Steamed Vegetables and Fish Offal Wrapped in Banana Leaf	Fish	Intestine	✓			[44]
58	Bobotok Hati Ampela	West Java	Liver and Gizzard <i>Bobotok</i> (Steamed Shredded Coconut Flesh Wrapped in Banana Leaf)	Chicken	Liver, gizzard	✓			[44]
59	Pais Hati Ampela	West Java	Steamed Meat and Vegetables Wrapped in Banana Leaf	Chicken	Liver, gizzard	✓			[44]
60	Soto Kuning	West Java	Yellow <i>Soto</i>	Chicken	Liver, gizzard	✓			[45]
61	Soto Bandung	West Java	Bandung <i>Soto</i>	Cattle	Tripe, Tendon, head skin		✓		[45]
62	Sate Jando	West Java	Nipple <i>Satay</i>	Cattle	Nipple	✓			[45]
63	Momoh	Central Java	Braised Offal	Cattle, Water Buffalo, Cattle	Tripe, intestine, liver, lung	✓			[46]
64	Pepes Endog Mimi	Central Java	Steamed Horseshoe Crab Ovary and Vegetables Wrapped in Banana Leaf	Horseshoe Crab ( <i>Tachypleus gigas</i> )	Ovary	✓			[46]
65	Babat Gongso	Central Java	Braised Tripe	Cattle	Tripe	✓			[46]
66	Nasi Goreng Babat Semarang	Central Java	Fried Rice with Braised Tripe	Cattle	Tripe		✓		[32]
67	Bakso Balungan	Central Java	Bakso (Meatballs) with Bone Marrow	Cattle	Bone, bone marrow		✓		[47]
68	Nasi Goreng Jerohan	Central Java	Fried Rice with Offal	Cattle	Tripe, intestine, liver		✓		[32]
69	Sate Kikil	Central Java	Tendon and Head Skin <i>Satay</i>	Cattle	Tendon, head skin	✓			[46]
70	Nasi Gandul	Central Java	Rice with Meat and Offal Stew	Cattle, Water Buffalo	Tripe, intestine		✓		[46]

**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
71	Gudeg Koyor	Central Java	Head Skin <i>Gudeg</i> (Javanese Unripe Jackfruit Sweet Stew)	Cattle	Head Skin	✓			[46]
72	Saren	Central Java	Javanese-styled Blood Pudding	Cattle	Blood	✓			[48]
73	Opor Ayam	Central Java	Javanese-styled Chicken Curry	Chicken	Liver, gizzard			✓	[29]
74	Sambal Goreng Ati-Ampela	Central Java	Liver and Gizzard Stewed in Chili Sauce	Chicken	Liver, gizzard	✓			[29]
75	Tongseng	Central Java	Sweetened Goat Meat and Offal Curry	Goat	Liver, intestine, tripe, lung		✓		[49]
76	Tengkleng	Central Java	Goat Bone Curry	Goat	Bone, bone marrow	✓			[49]
77	Kerupuk Rambak	Central Java	Water Buffalo Skin Chip	Water Buffalo	Skin	✓			[50]
78	Tauto Pekalongan	Central Java	Meat and Offal Soto Seasoned with Fermented Soybean Paste	Cattle, Water Buffalo	Liver, intestine, tendon		✓		[29]
79	Sate Babat	Central Java	Tripe <i>Satay</i>	Cattle	Tripe	✓			[29]
80	Soto Tegal	Central Java	Tegal-styled Soto	Cattle	Liver, tripe, tendon, intestine		✓		[29]
81	Sambal Krecek	Yogyakarta	Cattle Skin in Spicy Sauce	Cattle	Skin	✓			[51]
82	Gudeg Yogya	Yogyakarta	Yogyakarta <i>Gudeg</i>	Chicken	Liver, gizzard, ovary		✓		[51]
83	Sate Ayam-Ayaman	Yogyakarta	Watercock <i>Satay</i>	Watercock ( <i>Gallicrex cinerea</i> )	Liver, gizzard			✓	[51]
84	Jeroan bacem	Yogyakarta	Braised Offal	Chicken	Liver, gizzard, ovary	✓			[51]
85	Entog Slenget	Yogyakarta	Goose Stew	Goose	Liver, gizzard, ovary		✓		[51]
86	Sate Uritan	Yogyakarta	Ovary <i>Satay</i>	Chicken	Ovary	✓			[51]
87	Brongkos	Yogyakarta	Javanese-styled Meat and Beans Stew	Cattle	Tendon, head skin, intestine, tripe		✓		[51]
88	Oseng-Oseng Mercon	Yogyakarta	Spicy Stir-Fried Tendon and Head Skin	Cattle	Tendon, head skin	✓			[51]
89	Jeroan Ungkep Goreng	Yogyakarta	Fried Braised Offal	Chicken, Cattle	Liver, intestine, gizzard, tripe	✓			[51]
90	Pecel Tumpang	East Java	Javanese-styled Salad with Lung Jerky Topping	Cattle	Lung		✓		[52]
91	Lontong Kikil	East Java	Tendon and Head Skin Curry with Rice Cake	Cattle	Tendon, head skin	✓			[52]
92	Nasi Jeroan Bangil (Nasi Pulen)	East Java	Rice with Offal Stew	Cattle	Liver, Intestine, head skin, tendon		✓		[52]
93	Nasi Krawu	East Java	Rice with Vegetables and Braised offal	Cattle	Tripe, lung, Intestine		✓		[52]



**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
94	Nasi Babat Madura	East Java	Rice with Braised Tripe	Cattle	Tripe		✓		[52]
95	Rujak Soto Banyuwangi	East Java	Banyuwangi-styled Salad and Soup	Cattle	Tripe, liver, intestine			✓	[52]
96	Soto Sulung	East Java	Madurese-styled Offal Soto	Cattle	Heart, liver	✓			[52]
97	Rujak Cingur	East Java	Lip Salad	Cattle, Water Buffalo	Lip	✓			[52]
98	Usik Kikil	East Java	Braised Cattle Tendon and Head Skin	Cattle	Tendon, head skin	✓			[52]
99	Soto Babat-Iso	East Java	Tripe and Intestine Soto	Cattle	Tripe, intestine	✓			[52]
100	Rawon	East Java	Beef Soup Spiced with <i>Pangium edule</i>	Cattle	Liver, tripe, intestine		✓		[54]
101	Krengsengan	East Java	Stir-Fried Chicken Stew	Chicken	Liver, gizzard, intestine			✓	[56]
102	Lodeh Kikil Jombang	East Java	Tendon and Head Skin in Vegetable Broth	Cattle	Tendon, head skin	✓			[56]
103	Soto Kikil	East Java	Tendon and Head Skin Soto	Cattle	Tendon, head skin	✓			[52]
104	Kwe Cap	West Kalimantan	Pig Skin Stew	Pig	skin	✓			[55]
105	Kwe Kia Theng	West Kalimantan	Pork Soup	Pig	Tripe, intestine, ears, etc		✓		[53]
106	Sop Tulangan Kutai	East Kalimantan	Cattle Bone Soup	Cattle	Bone	✓			[57]
107	Sambal Gami	East Kalimantan	Gami <i>Sambal</i> (Chili Sauce)	Chicken	Liver, gizzard			✓	[58]
108	Lawar Merah	Bali	Balinese Mixed Vegetable with grated coconut flesh and pig blood	Pig	Blood		✓		[59]
109	Urutan	Bali	Balinese-styled Blood Sausage	Pig	Blood, intestine	✓			[59]
110	Sate lilit	Bali	Minced Pork <i>Satay</i>	Pig	Intestine, tendon, liver		✓		[59]
111	Be' Balung	Bali	Balinese-styled Pig Bone Soup	Pig	Bone, bone marrow	✓			[60]
112	Rawon Babi	Bali	Pork <i>Rawon</i>	Pig	Tripe, intestine, bone		✓		[59]
113	Soto Babi	Bali	Balinese Pork Soto	Pig	Bone, bone marrow		✓		[59]
114	Babi Nyat-Nyat	Bali	Balinese Grilled Pork Stew	Pig	Tripe, skin, intestine		✓		[60]
115	Sate Plecing	Bali	Salad and Pork <i>Satay</i>	Pig	Tripe, intestine, skin		✓		[59]
116	Bebalung	West Nusa Tenggara	Sweetened Bone Curry	Cattle	Liver, tripe, intestine, Oxtail, Bone, Bone Marrow	✓			[61]

**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
117	Sate Ampet	West Nusa Tenggara	Ampet <i>Satay</i>	Cattle	Liver, intestine, tripe			✓	[61]
118	Se'i	East Nusa Tenggara	Smoked Meat	Cattle, Pig	Tripe, lung, intestine, tongue			✓	[62]
119	Rica-Rica Hati Ampela	North Sulawesi	Liver and Gizzard Spicy Stew	Chicken	Liver, gizzard	✓			[63]
120	Rica-Rica Babi	North Sulawesi	Pork Spicy Stew	Pig	Liver, tripe, intestine		✓		[63]
121	Rica-Rica tulang	North Sulawesi	Bone Spicy Stew	Chicken	Bone	✓			[63]
122	Brenebon	North Sulawesi	Pork/Pig Offal and Beans Soup	Pig	Tendon, liver		✓		[63]
123	Rintek Wuuk	North Sulawesi	Minahasan Canine Meat and Offal Stew	Dog	Blood, intestine, liver		✓		[63]
124	Ilabulo	Gorontalo	Gorontalo-styled Steamed Chicken Offal Wrapped in Banana Leaf	Chicken	Liver, gizzard	✓			[64]
125	Kaledo	Central Sulawesi	Bone, Tendon and Head Skin Soup	Cattle	Bone, bone marrow, tendon, head skin	✓			[65]
126	Pa'piong Babi	South Sulawesi	Vegetables and Pork/Pig Offal Cooked Inside Bamboo	Pig	Intestine, tripe			✓	[66]
127	Pa'piong Burak	South Sulawesi	Chopped Banana Stems and Chicken Meat/Offal Cooked Inside Bamboo	Chicken	Intestine, liver, gizzard			✓	[66]
128	Pa'piong Duku	South Sulawesi	Chicken/Chicken Offal Cooked Inside Bamboo	Chicken	Tendon, liver, gizzard			✓	[66]
129	Dangkot	South Sulawesi	Torajan-styled Spicy Chicken Stew	Chicken, Duck	Liver, gizzard		✓		[66]
130	Tollo Pamarasan	South Sulawesi	Torajan-styled Braised Meat/Offal	Chicken, Water Buffalo, Pig	Liver, tripe, intestine		✓		[66]
131	Pallubasa	South Sulawesi	Coconut Milk-based Offal Soup	Cattle	Liver, intestine, tripe, lung	✓			[66]
132	Sop Saodara	South Sulawesi	Offal Soup	Cattle	Bone, Tendon, Tripe, Intestine, lungs	✓			[66]
133	Konro	South Sulawesi	Cattle Bone Spicy Soup	Cattle	Bone, Bone Marrow	✓			[66]
134	Coto Makassar	South Sulawesi	Makassarese-styled <i>Soto</i>	Cattle	Tendon, head skin, intestine, tripe		✓		[66]
135	Sop Buntut	Ubiquitous	Oxtail Soup	Cattle	Oxtail	✓			[54]
136	Keripik Usus	Ubiquitous	Intestine Chip	Chicken	Intestine	✓			[29]

**Table 1** (continued)

No	Name of dishes	Regions of origin	English equivalent name of dishes	Sources of offal	Types of offal	The use of offal in the dish			References
						Main ingredient	Secondary ingredient	Alternative ingredient	
137	Bakso Jerohan	Ubiquitous	Bakso with Offal Topping	Cattle	Liver, intestine, tripe, head skin, tongue, tendon, bone, bone marrow, trotter, lip, eyes		✓		[67]
138	Ceker Mercon	Ubiquitous	Chicken Leg stewed in Hot Chili Pepper Sauce	Chicken	Leg	✓			[68]
139	Mie Ayam Ceker	Ubiquitous	Chicken Noodle with Chicken Leg Topping	Chicken	Leg		✓		[69]

readers of CNN Travel voted *rendang* as the world's most delicious food [26].

Initially, instead of adopting the Indian curry, Javanese and Sundanese people tended to develop their indigenous dishes [17]. Some ancient Javanese delicacies, which were usually served during religious offerings and royal dining banquets, have been recorded in a number of ancient inscriptions (AD 900–928) from the Mataram Kingdom (AD 716–1016). Some examples include *wrak-wrak* (interpreted as the modern *urap/lawar*, or mixed vegetables with grated coconut flesh), *rarawan* (interpreted as the modern *rawon*, or meat soup spiced with *Pangium edule*), *rurujak* (interpreted as the modern *rujak*, or spicy salad), *hadanan madura* (buffalo meat cooked in a sweet palm sugar), and *dundu puyengan* (eel cooked with lemon basil) [70]. Unfortunately, the presence of OBDs in ancient Java has not been clearly documented in any inscription. The ancient use of offal in dishes can be traced from the modern versions of ancient Javanese dishes as well as their Balinese counterparts, as the Balinese culture is a continuation of the ancient Javanese Hindu civilization [19]. For instance, the utilization of blood in *lawar* (Balinese mixed vegetable with grated coconut flesh) and pig offal in *rawon babi* (Balinese pork *rawon*) proves that offal was probably used in the ancient dishes (*wrak-wrak* and *rarawan*, respectively) (Table 1) [59]. This is also supported by the fact that in East Java, cattle offal (tripe, liver, and intestine) is often incorporated into the *halal* version of *rawon* as a secondary source of protein along with beef [52]. Meanwhile, in minority non-Muslim Javanese communities, *rujak* is often served with fried *saren* (blood pudding) [70]. It is hypothesized that offal had been consumed by the common Javanese people in ancient times but was probably not served during rituals and in royal palaces because

it was considered impure (hence, not mentioned in the inscriptions) [70]. In contrast, the sacred offerings and imperial tables usually served the finest parts of an animal (i.e., the meat) [70]. Interestingly, today, the Balinese *lawar merah* (*lawar* mixed with blood) (Fig. 1C) is not only a delicacy for the common people but also favored by Balinese royal families and used as an offering during rituals, which demonstrates that offal is more acceptable by Balinese higher societies rather than their ancient Javanese counterparts [59]. Even the tradition of cooking *lawar* collectively (*nglawar*) is viewed as a concept to enhance the unity of Balinese people coming from different backgrounds [59, 71]. Meanwhile, in Western Java, offal is added in Sundanese delicacies such as *piritatan* (steamed vegetables and fish offal wrapped in banana leaf), *pais* (steamed meat and vegetables wrapped in banana leaf), and *bobotok* (steamed shredded coconut flesh wrapped in banana leaf), all of which have a historical tie to the ancient Pajajaran Kingdom (Table 1) (thirteenth–fifteenth century) [72].

In the period of Islamization in Java (around the fifteenth century), non-*halal* ingredients were entirely omitted from the indigenous dishes [70]. In Islamic dietary law (*halal* law), the consumption of pork and blood is strictly prohibited [73]. The incorporation of *saren* (blood pudding) in *rujak*, for example, was probably replaced with *cingur* (the lip of water buffalo), which has a similar meaty characteristic (Table 1, Fig. 1D) [48, 70]. Meanwhile, the rulers of some Islamic sultanates in Java also decreed a law banning cattle slaughtering as a religious tolerance to honor Hindu communities in their realms [46, 70]. In Hinduism, cattle are venerated since regarded as the incarnation of *Nandi Deva* (the bull of Lord Shiva); hence, the cattle slaughtering is forbidden [17]. Therefore, the Muslim citizens slaughtered water

buffalo, goat, sheep, and other *halal* animals instead, even developing dishes based on their meat and offal [46]. An example comes from Kendal Regency, located on the northern coast of Central Java, in which *momoh* (braised offal) was historically created from water buffalo offal in the early period of Islamization (around fifteenth–sixteenth century) (Table 1, Fig. 1E) [46]. *Momoh* is derived from the Javanese word for rejection, “*emoh*,” which historically signifies an initial rejection of the dish due to its dark brown appearance [46]. The offal is slowly cooked for up to two days in a sweet palm sugar-based seasoning, which is reminiscent of the ancient Javanese dish of *hadanan madura* (tenth century) [46, 70]. Curry-like dishes were probably developed in Java after the arrival of Arab, Indian, and Malay Muslim traders, who introduced Islam to the region [46, 70]. It has been suggested that the late adoption of curry in Java was to create a cuisine with a new religio-cultural identity (Muslim cuisine) that could be differentiated from indigenous Hindu cuisine [46, 70]. For instance, *rabeg* (Bantenese-style mutton curry) is a delicacy developed by the people of Banten (Western Java) using mutton and sheep offal that was a favorite of some Bantenese sultans and considered an intangible cultural heritage of the Bantenese Islamic Sultanate (1527–1813) (Table 1, Fig. 1F) [3, 41]. *Rabeg* resembles the Yemeni-style goat curry, which demonstrates an Arab-Islamic influence on Bantenese cuisine [41]. Another example is *opor ayam* (Javanese-style chicken curry), created by the *Wali Sanga* (the nine Islamic saints) using chicken (sometimes added with liver and gizzard) and served with *ketupat* (rice cake), which was used for Islamic preaching (*dakwah*) during Java’s Islamization period (around 15–sixteenth century) (Table 1) [46]. Furthermore, Java’s adaptation of curry-like dishes and its initial use of coconut milk have been historically documented in a famous chronicle called *Serat Centhini*, which was written in the Islamic Mataram Sultanate era (1586–1755) [74].

Since the thirteenth century, Chinese people have also migrated in waves to the Indonesian archipelago and established colonies (*Pecinan*, or Chinatowns) in some Indonesian regions, which play an indispensable role in the spread of Chinese culture, including Chinese cuisine, in the country [54]. Some Chinese delicacies were exclusively developed in Indonesian Chinatowns, such as *chasio Medan* (braised pork, which originated in Medan, North Sumatra), *sekba* (braised pork and pig offal, which originated in the Glodok district, Jakarta), and *kwe cap* (pig skin stew, which originated in Singkawang, West Kalimantan), involving the use of pig offal (Table 1) [28, 42, 54, 55]. According to Chinese culinary wisdom, all parts of an ingredient (including offal) must be entirely utilized to minimize wastage [54]. In Indonesia, the

Chinese culinary tradition was gradually absorbed and assimilated along with local and other foreign cuisines, inspiring the creation of various fusion dishes (Peranakan cuisine) [54]. The creation of *soto* (soup), for instance, is a proof of the influence of Chinese culinary tradition on Indonesian cuisine. The word “*soto*” comes from the Chinese words “*shao*” (which means cooking) and “*du*” (which means beef or offal), signifying that *soto* was initially made with cattle offal [75]. The quintessence of old version of *soto* can still be discovered in some modern *soto*, such as *soto babat-iso* (tripe and intestine *soto*) and *soto sulung* (Madurese-styled offal *soto*) [56, 75]. Furthermore, *soto Medan* is a Chinese rice vermicelli-based soup combined with spicy coconut milk-based curry broth and *halal* meat (sometimes incorporating *halal* offal along with the meat), demonstrating a fusion cuisine (Table 1) [75]. Moreover, in Pekalongan, a town in Central Java, *tauco* (Chinese fermented soybean paste) is incorporated into a spicy water buffalo meat and offal soup, creating a specialty known as *tauto Pekalongan* (Table 1) [46, 54, 75]. The Chinese population also introduced a stir-frying technique that involves cooking in a pan with a small amount of oil. This cooking technique has inspired the locals of Semarang in Central Java to develop a specialty made of cattle tripe called *babat gongso* (stir-fried cattle tripe) (Table 1, Fig. 1G) [46, 54].

In the late sixteenth century, new ingredients from Central America such as cassava, chili pepper, peanut, and vanilla were introduced by European merchants (particularly by Spanish and Portuguese merchants), making Indonesian cuisine more vibrant [54, 76]. The addition of chili pepper has increased the level of spiciness of local dishes such as *rendang*, *gulai*, and *kalio*, encouraging people to eat more [20, 21]. Moreover, the presence of chili pepper in Indonesia has inspired the creation of various recipes of *sambal* (chili paste), such as *sambal goreng ati-ampela* (liver and gizzard stewed in chili sauce) from Central Java and *sambal krecek* (cattle skin in spicy sauce) from Yogyakarta, which were probably created in the Mataram Sultanate era (1586–1755) and are still served during local feasts such as *selamatan* in Java (Table 1) [4, 51, 58, 70, 77].

Furthermore, the arrival of peanuts has also contributed to enrich the variation of Indonesian cuisine. In the late sixteenth century, a nutty-flavored soup called *coto Makassar* (Makassar-style beef soup) was created from a mixture of beef and cattle offal (tripe, intestine, tendon) stewed in a peanut milk-based curry broth (Table 1, Fig. 1H) [66]. It is usually served with *burasa* (rice cake) [66]. Initially, the dish used to be served as breakfast for the soldiers of the Gowa Sultanate in South Sulawesi [66]. This homogenous fusion of *soto* (Chinese-style soup), Indian curry, peanut (a foreign ingredient), *halal* meat

and offal, and local seasonings in the form of a scrumptious dish demonstrates that Makassar (the capital of the Gowa Sultanate) was a busy area and a junction of various cultures at that time [66].

The Dutch colonists also brought their culture, including their culinary traditions, to Indonesia, which was later absorbed and assimilated with the local culture [78, 79]. Here, the European-style meat soups were adopted by the natives using local ingredients and seasonings [54]. Unfortunately, in the colonial period, meat was only affordable to and enjoyed by the Dutch, Indos (people of mixed ethnicity due to the intermarriage between locals and Europeans), and native aristocratic families [78–80]. On the other hand, the common native inhabitants were mostly destitute and could not afford meat. Therefore, they creatively developed a European-style soup made of the tail, bone, and bone marrow of cattle known as *sop buntut* (oxtail soup) (Table 1) [54]. A similar economic reason is also experienced in the creation of *soto Betawi* (Betawi soto), *soto tangkar* (cattle bone and trotter soto), and *sop kaki kambing* (goat trotter soup), for which offal of cattle and goat (including intestine, tripe, liver, trotters, bone, and bone marrow) was innovatively exploited by the proletarians in Batavia (now Jakarta) during the colonial times, as the price of fine meat was quite exorbitant (Table 1) [9, 80].

Historically, offal also became a traditional salary system for butchers [66]. The owners of an animal would usually pay a butcher with offal as wage after obtaining the meat [66]. For instance, in South Sulawesi, these activities inspired the birth of *pallubasa* (coconut milk-based offal soup), in which the offal obtained as a salary after butchering (*tawana papolonga*) was cooked in a spicy coconut milk-based broth (Table 1) [66]. This delicious dish was subsequently enjoyed by the working class as a low-price food, as offal was an economical and affordable ingredient in that time [66]. *Pallubasa* differs from its *coto Makassar* counterpart due to its utilization of coconut milk instead of peanut milk [66].

After the independence of Indonesia in 1945, comprehensive efforts were made to strengthen the country's sense of nationality and unity [1]. One such effort was the creation of a new dish to inspire brotherhood among people. In South Sulawesi in the 1950s, an offal-based soup called *sop sodara* (which means “the brotherly soup”) was developed by a famous culinary entrepreneur using cattle offal (tendon, tripe, intestine, and lung) (Table 1) [66, 81]. The name for the dish was chosen in order to improve the brotherhood among the diverse people in South Sulawesi in the post-independence era [66, 81].

The creation of Indonesian OBDs is a continuous process that is going on even today. Nowadays, offal is often added as a topping into some modern Indonesian dishes

not only because it is an economical ingredient for food traders that allows them to minimize their operational costs, but also because it offers a sense of abundance that attracts the attention of Indonesian millennials [82, 83]. For example, Indonesian's legendary and ubiquitous *bakso* (meatball) is often served with an abundance of offal toppings (including liver, intestine, tripe, head skin, tongue, tendon, bone, bone marrow, trotter, lip, and even eyes of cattle), a combination that is famously known as *bakso jeroan* (meatballs with offal topping) (Table 1, Fig. 11) [82]. Moreover, Indonesian millennials are also keen to consume spicy dishes because spiciness is believed to have a therapeutic effect that can relieve stress and help the mind as well as the body relaxed after routine activities [84]. A spicy street food that is enjoyed by millennials is *ceker mercon*, which is made of chicken legs stewed in a hot chili pepper sauce (Table 1). This millennial dish was possibly inspired by the traditional *oseng-oseng mercon* (spicy stir-fried tendon and head skin), in which cattle tendon and head skin are stir-fried and then cooked in a chili pepper sauce [51]. Here, the term “*mercon*,” which is a Javanese word for “the firecracker,” is used in the name of such dishes to hyperbolically illustrate the level of spiciness of the dishes [51]. In addition, these delicacies are not only a favorite of the working class but also of the higher class, which includes celebrities, aristocrats, and artists [85]. This suggests that there has been a cultural shift that valorize the value of offal in modern Indonesia [9]. Furthermore, the valorization of offal is not only experienced in the modern OBDs, but views on the traditional OBDs have also gradually been changed in which *se'i lidah sapi* (smoked cattle tongue) and *gulai tunjang* (tendon and head skin curry) are more expensive than meat-based dishes like *se'i daging sapi* (smoked beef) and *rendang daging* (beef rendang), respectively [9, 86, 87]. Even, in many Minangkabau restaurants, OBDs such as *gulai tunjang*, *gulai otak*, *gulai tambusu* and such are usually displayed in a separated plate which can further improve the feeling of exclusiveness and luxury [21, 88]. Thus, those exhibit that OBDs are currently a laudatory food that are more appreciated by Indonesians rather than previous periods.

### The distribution of Indonesian offal-based dishes

This section recapitulates Indonesian OBDs (139 dishes) from all regions of Indonesia based on their origin, offal source, type of offal, and offal utilization in dishes (Table 1). In terms of origin, OBDs are geographically distributed in 23 provinces in Indonesia, where the diversity of these foods varies in each province (Table 1; Fig. 2). Most OBDs are centralized in West Sumatra, Central Java, and East Java, each of which has contributed with 31, 18, and 14 dishes, respectively (Table 1; Figs. 2



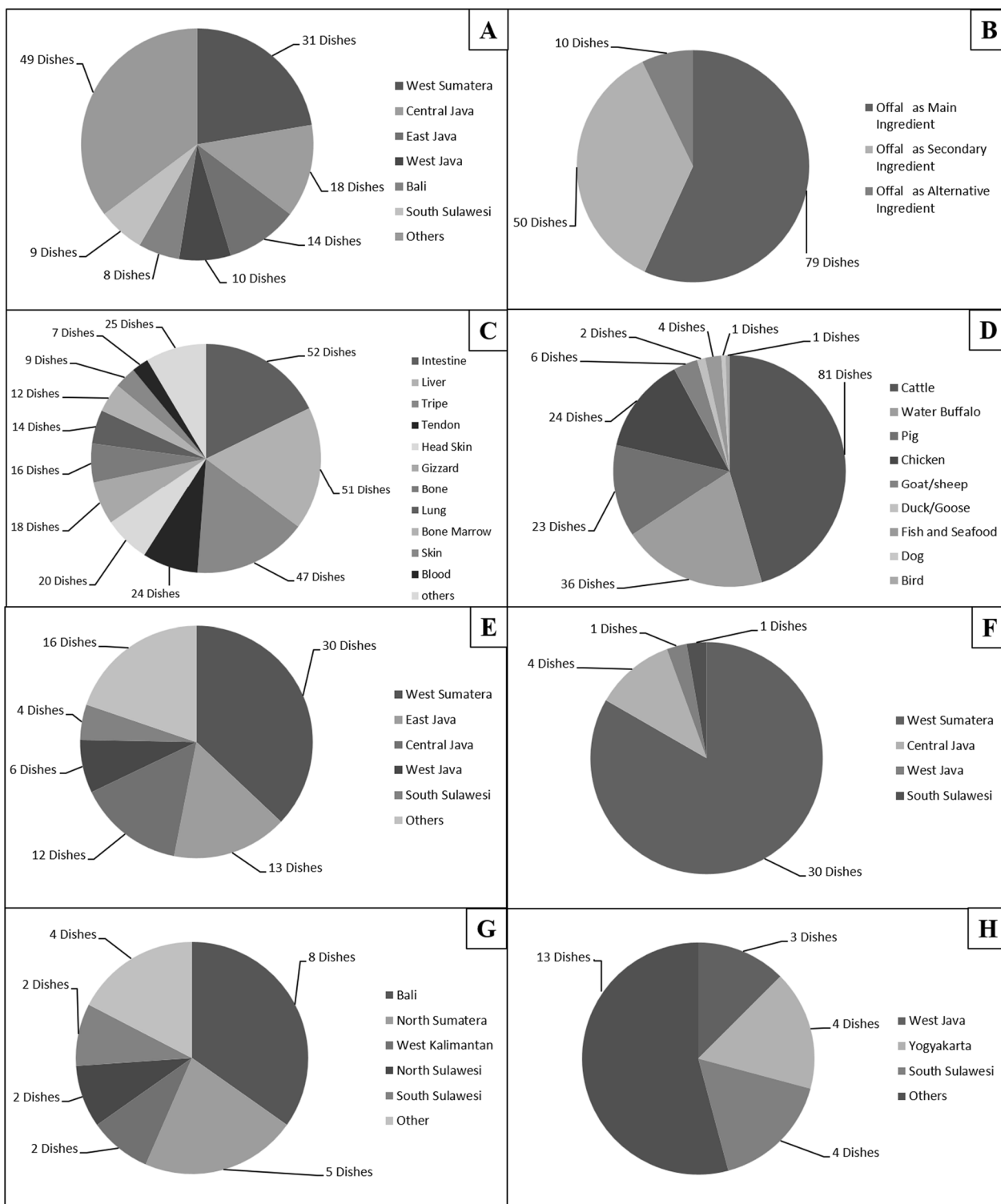
Fig. 2 The geographical distribution of Indonesian OBDs

and 3A). Meanwhile, OBDs are extremely rare on the eastern coast of Sumatra, Kalimantan, parts of Sulawesi, and the Eastern Indonesian provinces (Table 1; Fig. 2). Moreover, OBDs are obviously absent in Moluccan and Papuan provinces in eastern Indonesia (Fig. 2). The only OBDs coming from eastern Indonesia is a smoked delicacy from East Nusa Tenggara, *se'i* (smoked meat), in which tripe, lung, intestine, and tongue of cattle and pig are sometimes added into the smoking process (Table 1; Fig. 2). It has been suggested that the diversity of OBDs in different regions in Indonesia is shaped by several factors such as culture, history, and natural resources [5, 20, 46, 52]. West Sumatra, Central Java, and East Java have strong cultural, historical, and gastronomical backgrounds associated with offal [20, 46, 52]. Furthermore, there are numerous animal husbandries established in those areas (West Sumatra, Central Java, and East Java) which not only produce animal products (meat, egg, milk and etc.) but also wastes (one of which is offal) [5]. The lower level of diversity in some areas of Indonesia (e.g., the eastern provinces of Sumatra, Kalimantan, parts of Sulawesi, and eastern Indonesia) is also caused by a tendency of using freshwater fish and seafood in dishes, which produces a less quantity of offal compared to the offal produced by domesticated livestock [3, 6]. In general, fish or seafood offal has traditionally been utilized as animal feed or fertilizer; therefore, the local dishes that use this ingredient do not vary [89]. The only examples of OBDs that incorporate fish/seafood offal are *keripik telur cumi* (squid ovary chip) from Bangka-Belitung, *piritan* from West Java, *gulai telur ikan* (fish ovary curry) from

West Sumatra and a specialty from Kendal Regency of Central Java called *pepes endog mimi* (steamed horse-shoe crab ovary and vegetables wrapped in banana leaf) (Table 1).

About 79 dishes utilize offal as the main ingredient, such as *balado kikil* (tendon and head skin spicy stew), *soto kikil* (tendon and head skin soup) and *rica-rica hati ampela* (chicken liver and gizzard spicy stew) (Table 1; Figs. 2 and 3B). Moreover, in 50 dishes, offal is incorporated to accompany the main ingredients (meat, rice, and vegetables), such as *soto babi* (Balinese pork soup), *nasi krawu* (rice with braised offal), and *gulai kambing Aceh* (Acehnese-style mutton curry) (Table 1; Figs. 2 and B). Sometimes, offal is also alternatively used as a substitute for meat, as discovered in 10 dishes, some of which are *sate ampet* (Ampet satay), *krengsengan* (stir-fried chicken stew), and *satay ayam-ayaman* (watercock satay) (Table 1; Figs. 2 and 3B). The priority of utilizing offal in a dish is determined by factors such as organoleptic and ethno-gastronomical backgrounds [3].

The intestine, liver, and tripe are the most commonly used offal in Indonesia, as discovered in more than 40 dishes (Table 1; Fig. 3C). This is due to an abundant volume of these organs (which amounts to about 20–25% of the animals' weight) collected after slaughtering, which encourages people to process them into foods instead of dumping them as waste [6, 7]. Meanwhile, offal such as tendon, head skin, gizzard, bone, lung, and bone marrow are moderately used in over 10 dishes (Table 1; Fig. 3C). Another kind of offal is the blood, which is enormously incorporated in seven dishes that originated



**Fig. 3** The geographical origin of OBDs (A); the use of offal in an OBD (B); the type of offal used in OBDs (C) and the source of offal (D). Meanwhile, the rest presents the geographical distribution of OBDs using cattle (E); water buffalo (F); pig (G); and chicken offal (H)

from Indonesian non-Muslim regions such as Bali, the Batakese region of North Sumatra, and etc. (Table 1; Figs. 2 and 3C).

Cattle offal is the most utilized offal source, as discovered in 81 dishes, followed by water buffalo and chicken offal (used in 36 and 24 dishes, respectively) (Table 1; Fig. 3D). The dishes are distributed in West Sumatra, Java Island (chiefly in Yogyakarta as well as East, Central, and West Java) and the Bugisnese region of South Sulawesi (Table 1; Figs. 2, 3D–H). The presence of a majority Muslim population in those areas is the main reason why those ingredients are employed [2]. Meanwhile, the non-*halal* offal (obtained from pigs and dogs) is used in some of the dishes discovered in provinces where the non-Muslim population is quite significant, such as in Bali (8 dishes), Tapanuli or Batakese region of North Sumatra (5 dishes), Singkawang region of West Kalimantan (2 dishes), Minahasan region of North Sulawesi (3 dishes), and Torajan region of South Sulawesi (2 dishes) (Table 1; Fig. 2, 3D, G) [2].

Additional file: 1 elaborates on the employment of spices, herbs, and other ingredients in offal cooking. Spices and herbs maintain the organoleptic aspect of OBDs, thereby further improving their deliciousness (Additional file: 1) [90]. Meanwhile, the preparations of offal and Indonesian OBDs are comprehensively elucidated and tabulated in Additional file: 2. The utilization of coconut milk is mostly discovered in OBDs of Sumatra (mainly in West Sumatra), parts of Java and Sulawesi, demonstrating the influence of Indian culinary tradition (Fig. 2 and Additional file: 1) [20, 21]. The addition of coconut milk in the OBDs can organoleptically enhance the savoriness of the dishes [20, 21]. Moreover, the addition of sesame oil, fermented soy products (i.e., soy sauce and soy paste), and shrimp paste into OBDs demonstrates the influence of Chinese culinary tradition, as discovered in parts of Java (including some Chinatowns in Java), the Singkawang region of West Kalimantan, and eastern Sumatra (the Medan region of North Sumatra, Bangka-Belitung, Riau Islands) (Fig. 2 and Additional file: 1) [54]. The addition of those ingredients in OBDs improves the umami flavor along with the other qualities such as saltiness, sourness, and sweetness, making these dishes more vibrant and scrumptious [54]. The Chinese culinary influence is also evident in the utilization of noodles and meatballs as discovered in some OBDs discovered in West Java (*soto mi Bogor*, or Bogor noodle soup) and Central Java (*bakso balungan*, or meatballs with bone marrow), as well as in ubiquitous dishes such as *bakso jerohan* and *mie ayam ceker* (chicken noodles with chicken leg topping) (Table 1, Fig. 2 and Additional file: 1) [54]. Furthermore, the influence of colonial culinary heritage in offal cooking is discovered in some

soup-based dishes such as *brenebon* (pork/pig offal and red bean soup) in North Sulawesi and the ubiquitous *sop buntut* (Table 1, Fig. 2 and Additional file: 1) [54, 78]. Additionally, OBDs such as *Saksang* from the Batakese region of North Sumatra and *pa'piong babi* (vegetables and pork/offal cooked inside bamboo) from the Torajan region of South Sulawesi tend to retain the native features of the Austronesian culinary tradition. Moreover, the trace of Columbian exchange in offal processing can be discovered in some dishes utilizing chili peppers and peanuts (Additional file: 1). Interestingly, chili pepper (*Capsicum annum*) is almost always used in Indonesian OBDs (Additional file: 1). The widespread utilization of this ingredient was due to the massive cultivation of chili pepper in the past after it arrived from Meso-America [4, 76]. Capsaicin not only improves the spiciness of OBDs but can also omit the unpleasant aroma of offal [4]. The use of another imported ingredient, peanuts (*Arachis hypogaea*), in the form of peanut paste or peanut milk, is discovered in *pecel tumpang* (Javanese-style salad with lung jerky topping) from East Java and *coto Makassar* from South Sulawesi, respectively (Table 1, Fig. 2 and Additional file: 1). The use of peanut milk in *coto Makassar* creates a particular flavor that tastes as savory as coconut milk [66].

## Conclusions

To summarize, Indonesian OBDs are a cultural heritage and intangible national asset which have been created and influenced by various factors such as natural resources, history, religio-cultural and economic backgrounds. In this archipelagic country, authentic recipes of OBDs vary greatly across regions, defining the diversity. Although OBDs (139 dishes) are widely distributed in 23 provinces of Indonesia, most of these dishes are concentrated in West Sumatra (31 dishes), Central Java (18 dishes), and East Java (14 dishes). The intestine, liver, and tripe are the most commonly utilized offal as they are utilized in over 40 dishes; while tendon, head skin, gizzard, bone, lung, and bone marrow are the second favorite. Moreover, cattle, water buffalo, and chicken are the most utilized sources of offal. Meanwhile, pig offal is only used and distributed in non-Muslim regions of Indonesia. On the one hand, the creation of Indonesian OBDs is influenced by foreign cultures, such as Indian, Arabian, Chinese, and Dutch-Colonial culinary traditions, while on the other hand, some OBDs retain the native features of Indonesian culinary tradition. Furthermore, the utilization of indigenous spices and herbs maintains the organoleptic attributes of OBDs. Additionally, foreign ingredients such as peanuts and chili peppers are discovered in several OBDs, demonstrating the trace of Columbian culinary exchange (Additional file: 3).



## Recommendations

This article is the first academic article in the world discussing on Indonesia OBDs. Thus, the manuscript can hopefully inspire people working in the related areas (food science, ethno-culinary science, gastronomy, and cultural science) to propose any researches related to Indonesian OBDs. Authors vehemently suggest to conduct any future studies related to a particular Indonesia OBD and its business aspect which can potentially enrich the national and international ethno-culinary databases. Furthermore, authors also open opportunities of any future research collaborations in that area. Moreover, authors suggest the government of the Republic of Indonesia and also UNESCO to conserve and register the Indonesian OBDs as the intangible world heritage. The government of the Republic of Indonesia should also introduce as early as possible these Indonesian OBDs through the national educational curriculum in Indonesian schools (through some subjects such as Biology, Geography, and Sociology) and include them as a part of National food security agenda.

## Supplementary Information

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**Additional file 1.** Spices, herbs and other ingredients utilized in Indonesian OBDs; in which a: garlic, b: shallot, c: chili pepper, d: black pepper, e: ginger, f: galangal, g: turmeric, h: lemongrass, i: coconut milk, j: coriander, k: candlenut, l: cumin, m: tamarind, n: liquorice, o: lime, p: star anise, q: bay leaf, r: soy sauce, s: shrimp paste, t: soy paste, u: sesame oil.

**Additional file 2.** Offal and Indonesian OBDs preparations.

**Additional file 3.** The example of mini-interview (Krengsengan).

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## Author contributions

IP, AAN and HKEPM designed the study, collected some literatures, tabulated and analyzed the data and were in charge of the manuscript writing. R and CD collected and tabulated the data and were in charge in organizing the references. All authors have read and approved the final manuscript before being sent.

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## Availability of data and materials

The data and material used in this work are available upon request.

## Declarations

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Not applicable.

### Competing interests

The authors declare no competing interests.

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