

REVIEW ARTICLE

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Rawon: the black soup delicacy from East Java

Erni Sofia Murtini^{1*}  and Befrika S. Murdianti²

Abstract

Rawon is a meat-based soup from the east of Java characterized by its black color due to the use of *keluak* seeds. Rawon is prepared through the boiling of meat with sautéed spices. The use of various spices resulted in a unique Rawon flavor liked by many. Rawon has existed for over a thousand years and is still very popular today. The delicious flavor of Rawon is not only loved by the local people of East Java but is also nationally recognized as one of Indonesia's traditional culinary icons and is internationally recognized as one of the best meat-based soups in the world. Rawon is usually served with rice, side dishes such as salted egg, and tempe, and various condiments such as mung bean sprouts, *sambal*, and *kerupuk*. Thus, Rawon not only satiates hunger but is also highly nutritious. *Nasi Rawon* or Rawon rice can be consumed for breakfast, lunch, or dinner. Rawon originated as a royal dish; however, presently it can be found anywhere and is sold in many food stalls and restaurants. It manifests a philosophy that although the Indonesian archipelago consists of many different ethnic groups, a harmonious life can be attained when they unite and coexist. Furthermore, this dish contains the philosophy of "*sugeng rawuh*" as a greeting to guests; therefore, Rawon rice is commonly served at weddings and community events or activities. This paper discusses in more detail the history of Rawon (including its origin and philosophy), the nutritional aspects, the ingredients, the process of making Rawon, and the chemical reactions that take place in creating the delicious flavor of the dish. The discussion also addresses presentation and on what occasions Rawon is served.

Keywords Rawon, Traditional black soup, *Keluak*, East Java, Indonesia

Introduction

Rawon is an Indonesian traditional meat soup famous for its black-colored broth. It is a signature dish from East Java that is usually eaten with rice, condiments such as mung bean sprouts, *sambal* (chili paste), and *kerupuk udang* (shrimp crackers), and side dishes such as tempeh and salted eggs.

The specific black color of Rawon is obtained from the use of *keluak* seeds. Its savory and delicious flavor is due

to the combinations of the meat components and the spices that consist of various herbs. Rawon can be consumed at any time as part of the diet for children, adults, and the elderly [1]. The quality of Rawon is determined by numerous factors such as the type of meat used, the completeness of the spices, and the cooking process. In general, customers in the Malang area preferred Rawon with a brownish-black broth color, savory flavor, and tender meat [2]. Consumers would return to the restaurants that serve Rawon with authentic and consistent flavor.

The main ingredients of Rawon are beef, spices, salt, and sugar [1]. Meats and spices are cooked for a long time to create a tender texture and rich broth. During cooking, there is a transfer of water and fat from the meat to the cooking water [3]. The flavor of the spices could mask the less desirable aroma of the meat and the addition of salt provides flavor and helps to bind the water

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and fat so that the shelf-life of the broth is longer. During the boiling process, micro/nano particles (MNPs) are formed in the broth [4]. These MNPs are circular-shaped colloidal systems with particle sizes from 400 to 1500 nm due to the accumulation of triglycerides and glycoconjugates produced as the result of lipid oxidation and Maillard reaction. These intermolecular interactions result in the accumulation of nutritional and flavor components in the MNPs [4]. Rawon is also often reheated to produce a more intense flavor. Reheating can significantly improve the taste and aroma of the soup due to increased levels of free amino acids, umami compounds (5'-inosine monophosphate, 5'-adenosine monophosphate, and 5'-guanosine monophosphate), and aromatic compounds [3].

The fine flavor of Rawon is not only acknowledged by the local people of Surabaya and East Java, but also nationally and internationally. Rawon is recognized as one of the 30 traditional Indonesian culinary icons selected by the Ministry of Tourism and Creative Economy in 2012 [5]. The selection process included ranking hundreds of traditional dishes from the 33 provinces in Indonesia that are considered as the province's iconic traditional dish. The criterion for the iconic traditional dish includes the use of uncomplicated ingredients widely known by the public that can be easily purchased. From the 30 traditional culinary icons, a set of menus is then created to be promoted globally and to be served in state banquets or special events nationally and internationally. Rawon has gained international recognition through *TasteAtlas*, which ranked Rawon first in "best meat-based soup in Asia" for the year 2020 and in the "Ten most popular meat soups in the world" in the years 2022 and 2023 [6].

Although Rawon has become increasingly famous, there are not many international documents revealing the history, philosophy, ingredients, preparation, nutrition, presentation, and consumption of Rawon. Therefore, this article aims to discuss Rawon from an ethnic perspective, including its origin, history, and philosophy. This article also discusses nutrition, ingredients, the process of making Rawon, and the chemical reactions that take place to create the delicious taste of the dish. The discussion also focuses on how, when, and on what occasions Rawon is served. The existence of Rawon can be preserved by maintaining the availability of good ingredients, consistent processes, and complete condiments [1].

Methods of review

This review analyzed and synthesized resources collected from various databases and search engines such as Science Direct, Google Scholar, Wiley Online Library, and MDPI. Additionally, resources were also collected from government agencies, national and international

newspapers and magazines. Resources from government agencies include data on meat production from Statistic Indonesia, cultural heritage records, archival ancient inscriptions, and historical records from the Indonesian Ministry of Education and Culture, and cattle farming history from the Indonesian Department of Animal Husbandry. Information crosscheck on popular publications was carried out by tracing various library resources to ensure the validity of the information. The history of Rawon was also discussed through email with experts in the history of traditional Indonesian food. The publication years for the literature used in this review range from 1985 to 2024.

The focus of this review includes the history, the nutrition, the raw ingredients, the cooking process (including the complex physical and chemical changes that take place), the condiments, and the presentation of Rawon. During the search for both Indonesian and English literature, the keywords used include 'rawon' ('history', origin, philosophy, nutrition, occasion), 'stewed beef/meat', 'beef broth', 'Pangium edule/keluak', 'sautéed spices', 'mung bean sprout', 'tempe', 'mendol', 'salted egg', 'shallot', dan 'kerupuk'.

To provide further detail for the review, a map of East Java was created to show the region (Surabaya, highlighted in yellow) where Rawon, originally royal cuisine in ancient Surakata, gained popularity among the common people and became an iconic dish. East Java shares a border with Central Java, where the city of Surakarta (highlighted in light yellow) is located. Figures of Rawon's raw ingredients, preparation process, cooking technique, and presentation were prepared. Additionally, two flow-chart diagrams were created to illustrate the step-by-step process of preparing *keluak* and Rawon.

The history and philosophy of Rawon

Rawon has been known since the ancient Javanese time. Although popular writings state that Rawon was recorded in the *Taji* inscription from 901 AD [7], the term Rawon is not found anywhere in the *Taji's* manuscript that is stored in the National Museum of Indonesia (inventory number E.12a-d; page 42–46) [8]. The *Taji* only records the information on the foods consumed by ancient Javanese people, such as rice, buffalo, chicken, salted food, jerky, fish, and eggs [9].

According to Prof. Timbul Haryono, an archeological expert from the University of Gajah Mada (UGM), Rawon has existed since the ancient Java era [10]. *Keluak*, the main ingredient of Rawon that creates its black color, was mentioned in *Serat Centhini*, one of the Javanese works published in 1814 that contain the history, philosophy, religion, mysticism, traditions of greatness, and art of the Javanese people [10]. The word 'keluwak' or *keluak*

is listed in *Serat Chentini*, volume 2, under the topic of “various dishes served as offerings for wedding celebrations” [11].

The use of meat, an expensive ingredient that was commonly only purchased by the royals, gives the impression that Rawon originated a royal dish. Confirming this assumption, in 1997, the Center for Traditional Food Studies in UGM found Rawon mentioned as *Rarawwan* or Rawon soup in the book *Kakawin Bhomokaya*, which was written by Mpu Panuluh from the Kadiri Kingdom that existed in East Java in 1042–1222. In Surakarta (highlighted on the map in Fig. 1), this dish was a favorite among kings and nobles. The first recorded recipe for Rawon appears in *Serat Wulangan Olah-Olah Warna-Warni*, the collection of recipes for *Mangkunegaran Surakarta Palace* printed in 1926 [12].

A question arises as to how Rawon has become an icon of East Java (depicted in Fig. 1). According to our correspondence with Mr. Fadly Rahman, a renowned Indonesian food historian from the University of Padjadjaran (UNPAD), Rawon has been a staple in East Java since the

nineteenth century. He suggested that the main reason Rawon became more popular in East Java can be attributed to the abundance of beef, the main ingredient of Rawon, which is more readily available in East Java than in Central Java. According to the East Java Province Livestock Service, livestock businesses in East Java have been in existence for many years since East Java’s population includes many farmers who raise draft animals such as oxen to plow the rice fields and as commodities. In 1860, *Schoolter Opleiding van de Veerartsnijkunst* (veterinary school) was founded in Surabaya, and in 1928 *Veerartsnijkundige Dienst* (Department of Veterinary Service) was established. According to the Dutch colony officials who had served in East Java, this area was the largest livestock producer in Indonesia at that time [13]. Data from Statistics Indonesia, a non-departmental government institute of Indonesia, showed that in 2022, East Java was the largest producer of beef in Indonesia with more than 5 million cattle, contributing 27% of Indonesia’s total beef cattle and 2.65 times more than what Central Java produces [14].



Fig. 1 The map of East Java and part of Central Java (right and left of the red line, respectively). Rawon is thought to have originated in the Kingdom of Surakarta (Central Java) as a royal cuisine. Over time, Rawon has transformed into a popular cuisine among commoners and a renowned delicacy in Surabaya (East Java). Note: The map is produced using QGIS and Google Earth applications. The map East Java is retrieved from <https://www.indonesia-geospasial.com/2020/01/shp-rbi-provinsi-jawa-timur-perwilayah.html?m=1> and the map of Central Java is retrieved from <https://www.indonesia-geospasial.com/2020/01/shp-rbi-provinsi-jawa-tengah-perwilayah.html?m=1>

Other corroboration that Rawon is a signature dish from East Java is that it has been recorded (Rawon, Registration Number 2013003845, year 2013) and designated (Rawon Nguling Probolinggo, Registration Number 201800733, year 2018) as an intangible cultural heritage of Indonesia under the domain of “traditional skills and crafts of the province of East Java” [15].

Aside from home cooking, Rawon can readily be found in many food stalls or restaurants in all parts of East Java and some parts of Central Java (Fig. 1). Rawon food stalls in East Java usually are named according to the location where it is sold, such as “Rawon Surabaya,” “Rawon Nguling,” the name of the owner of the food stall, such as “Rawon Mbok Yem,” or the time when the Rawon is sold, such as “Warung Setan,” which opens at 2 AM [1]. Furthermore, as many people from East Java migrated to other cities in Indonesia or abroad and introduced Rawon to the new areas, Rawon became recognized globally. Presently, Rawon is not only served in the food stalls or restaurants in East Java, but also in various cities in Indonesia and abroad.

In the past, Rawon seasoning was prepared fresh prior to cooking. One of the main ingredients in Rawon is *keluak* which is not always available in certain places. This caused some challenges to cook Rawon. However, with advances in technology, food industries are able to process and provide Rawon seasoning with a long shelf-life. With these advancements, Rawon seasoning can be distributed globally, and people anywhere can cook and consume Rawon. The shelf-life of Rawon instant seasoning produced by small and medium enterprises (SMEs) can reach up to 241 days, determined by the accelerated shelf-life testing (ASLT) method using the free fatty acids as the parameter [16].

Philosophically, the ingredients for Rawon consist of various spices with strong aromas, which represent the diversity of Nusantara (Indonesia). Indonesia is a diverse nation; however, when these diversities are united, the outcome is a harmonious system, just like various spices that are used to make Rawon combine in a pot to produce a very delicious dish [17]. Another source mentioned that Rawon has a *sugeng rawuh* philosophy, which means to welcome respected guests. For this reason, Rawon is often served at significant events, such as weddings and banquets [18].

The nutrition facts of Rawon

The use of different ingredients and cooking methods result in different Rawon qualities [2]. From six home-made samples and five samples made elsewhere in Malang, Rawon contributes $88.38 \pm 0.24 - 201.06 \pm 0.14$ 88 kcal calories per serving, with the fat content of $9.86 \pm 0.18 - 17.62 \pm 0.19\%$ depending on the amount of

meat, recipe used, and the cooking methods [2]. Rawon typically contains 86% water content, 60 kcal energy per 100 g, 5.4% protein, 2.5% fat 4% carbohydrates, and 2.1% ash content that contains minerals (mg/100 g) such as: calcium (272), phosphor (153), and iron (3.3). The vitamins contained in Rawon include carotenoids (1235 $\mu\text{g}/100\text{ g}$) and thiamin (0.09 mg/100 g) [19].

The ingredients of Rawon

The meat

The meat commonly used for Rawon is beef shank, brisket, or trimmings [20]. Presently, Rawon can also be made using oxtail, ribs, and beef kneecaps. The latter has become an iconic dish for certain restaurants. To make Rawon, the meat needs to be boiled to tenderness [2]. Long cooking times can result in partial structural changes or denaturation of proteins, as well as collagen solubilization, weakening the connective tissue and making the meat tender [21]. When using a knuckle portion of meat with 70.8% water content, 21.9% protein, 1.10% fat, and less than 0.1% sugar, the longer the boiling process produces broth that contains a higher concentration of umami amino acids [22]. The concentration of Asp and Glu amino acids can reach a maximum of 804.42 and 151.70 $\mu\text{g}/\text{g}$, respectively, within 4 h of boiling. At the same time, the concentration of bitter amino acids decreases with the longer boiling process. The concentration of 5'-nucleotides in the broth becomes higher as compared to the concentration in raw beef. The addition of other spices, salt, and sucrose also helps the release of amino acids into the broth. The presence of oil in sufficient amounts also helps to release the flavor substances into the broth. The main components that affect the broth flavor are the amino acids Asp, Glu, Pro, Ala, Val, Met, Arg, and tartaric acid [22].

The spices

Rawon spices are comprehensive (Fig. 2), consisting of *keluak* (*Pangium edule*), shallots (*Allium cepa var ascalonicum* L Back), garlic (*Allium sativum*), candle-nuts (*Aleurites moluccana*), coriander (*Coriandrum sativum*), red chilis (*Capsicum annum*), black pepper (*Piper nigrum*), cumin (*Trachyspermum roxburghianum*), ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), cutcherry (*Kaemferia galanga*), galangal (*Alpinia galanga*), shrimp paste, kaffir lime leaves (*Citrus hirtix*), scallions (*Allium cepa*), lemongrass (*Cymbopogon nardus*), sugar and salt [1]. *Keluak* is the main ingredient with the highest amount (14.28%), the same amount as shallots, red chilis, and scallions combined [20]. Each ingredient contains a specific component that contributes to a certain flavor. The combination of these components produces a complex and complete taste.



Fig. 2 Rawon seasoning inside a stone mortar. From left to right, top row: lemon grass, kaffir lime leaves, red chili. Second row: turmeric, ginger, galangal, candlenut, coriander, fermented shrimp paste (terasi). Third row: Keluak. Bottom row: sugar and salt, shallot, garlic, fennel seeds. Note: own work

The spices used in the making of Rawon not only give certain flavors but are also good for health. Bioactive components such as polyphenols with their antioxidant activities have been linked to reducing the risk of disease [23]. Although the heating process in cooking can affect the antioxidant activities, these bioactive components still have positive effects on the food. Li et al. reported that subjects who consumed burgers with added spices and herbs (black pepper, garlic, cloves, cinnamon, ginger, paprika, oregano, and rosemary) have a lower concentration of malondialdehyde (a biomarker of oxidative stress) in the plasma and urine than those who consumed control burgers with no added spices and herbs [24].

Rawon is usually laborious to prepare and cannot be served quickly. One way to quickly serve Rawon is by cooking it using commercial premade seasonings. The premade seasonings are usually packaged in the form of a paste, one batch. However, there is also premade seasoning in the form of powder, where the preferred ratio of powdered seasoning to broth is 1:27.5 [25].

Keluak

The seeds from the tropical plant *Pangium edule* Reinw, also known as *picung*, *pangi*, or *kepayang*, can be processed as *keluak* [26, 27]. *Picung* seed has a thick and hard outer skin with white endosperm covered by a thin brown membrane. It contains flavonoids and tannins that can be used as food preservatives. The people of *Batusangkar*, West Sumatra, have used the dried pulp of *picung* seeds mixed with shredded coconut to preserve mackerels. This product is called *pado* fish [28].

The raw seeds cannot be consumed immediately due to the cyanogenic glucoside content.

There are several steps to produce *keluak* from the raw seeds (Fig. 3). The freshly picked fruits are left in the field for ten days until the color turns black. The fruits are then cut open and the seeds are taken, washed, and boiled for three hours. The seeds are then fermented spontaneously by burying them in the ground or covering them with ashes for 40–60 days. The seed's chemical compositions are altered during the fermentation process. There is an increase in the fat content, especially oleic and linoleic fatty acids, and γ -tocotrienol, and the fat color becomes darker due to lignin degradation. The content of the β -glucosidase enzyme also increases, causing the elevation of the total phenolic content, reducing sugar, and the lowering of cyanogenic glucoside content. The concentrations of total carbohydrates and fibers are also lowered, but the amount of protein and amino acid compositions are not altered. The fermented seed is called *keluak* and is used as Rawon seasoning [27]. During the making of *keluak*, the cyanide content decreases from 15.18 $\mu\text{g/g}$ in the raw seed to 4.64 $\mu\text{g/g}$ after boiling. After 60 days of fermentation process using husk ash media, the cyanide content decreases further to 0.04 $\mu\text{g/g}$, lower than the allowable cyanide content for consumption (not exceeding 10 ppm). Fermented *keluak* has smooth, fatty, and blackish flesh, with 59.6% water content, 2.59% ash content, and 22.07% protein content [26]. Aside from its use as seasoning, *keluak* also has the ability to bind to cannabinoid CB1 receptors, making *keluak* an anti-obesity bioactive component [29].

Not all *keluak* in the market can be used as seasoning since there are *keluak* with bitter flavors or that are too acidic. Therefore, before the *keluak* is used, its flesh must be tasted first. There are no standard criteria for choosing a good *keluak*, but there are several benchmarks such as it feels heavy in hand, the meat is moist or not too dry when the shell is opened, it is black in color, it is not covered with mold, and it does not have a bitter taste [30].

How to Process Mature Pangli Fruits to Keluak

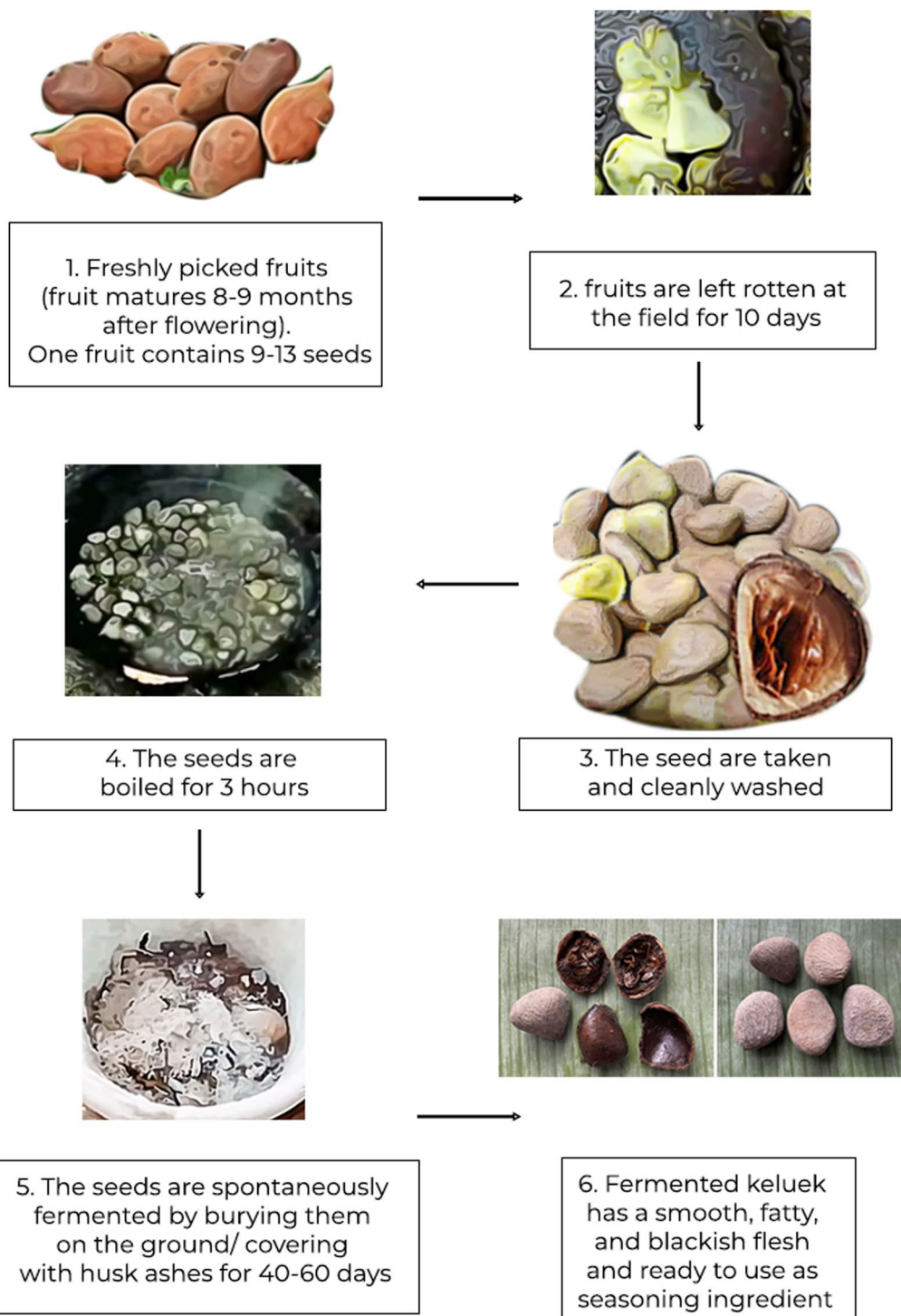


Fig. 3 Schematic diagram of *keluak* processing

The processing of Rawon

Rawon is processed through three stages: the making of the seasoning, the boiling of the meat, and the addition

of the seasoning into the boiled meat and broth (Fig. 4). The seasoning is prepared by grinding all ingredients into a paste using a mortar and a pestle traditionally or using

How to Prepare Rawon

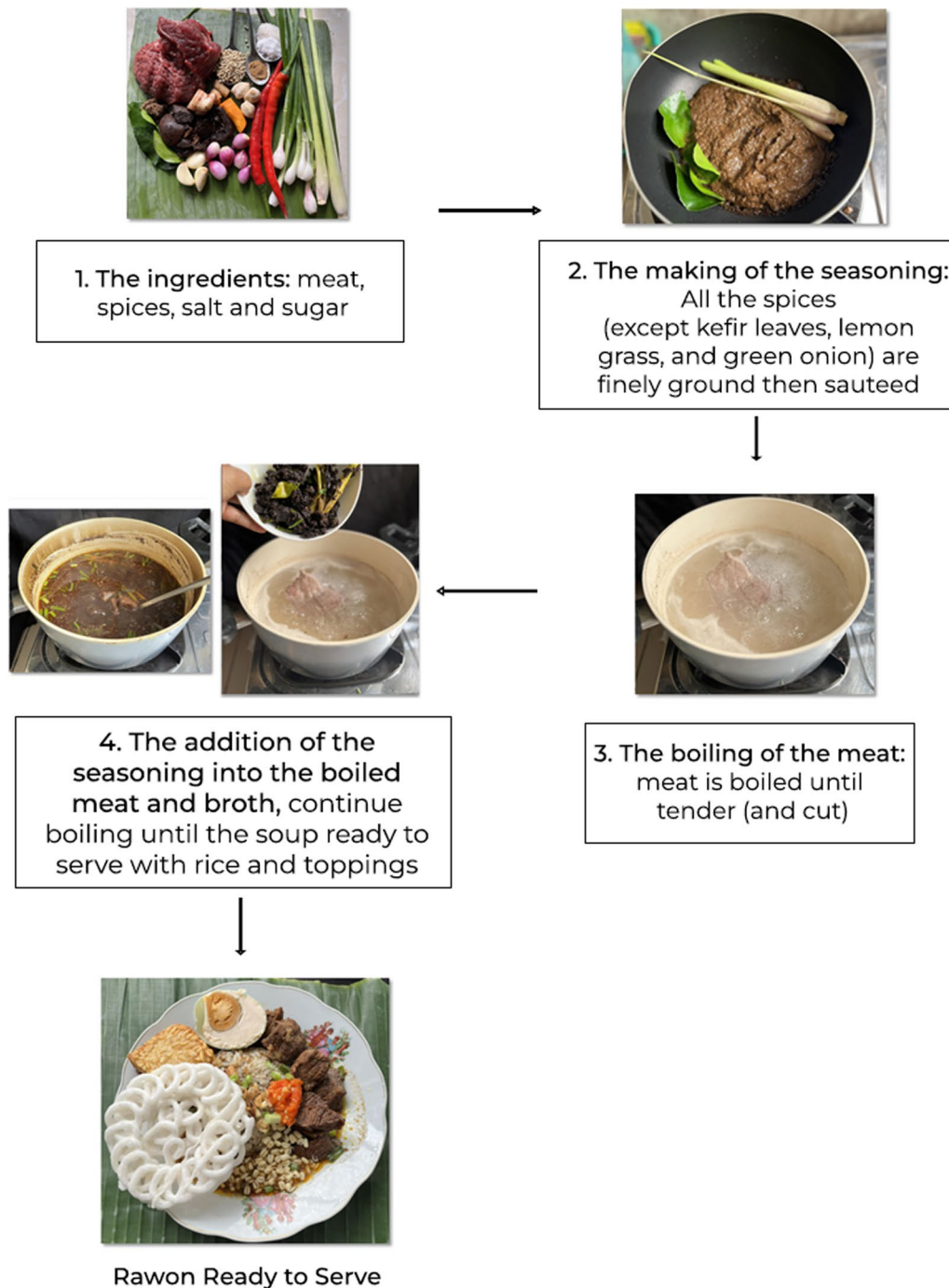


Fig. 4 Schematic diagram of preparing Rawon, from raw ingredients to serving

a grinder in mass production. The seasoning paste is then sautéed using oil to dissolve the seasoning components that are soluble in oil. The heat from the sautéing process can facilitate the water content reduction, the release of the flavor components in the Rawon seasoning, the formation of the Maillard reaction, the caramelization of sugar, and the reaction between ingredients to produce new complex components. Sautéing also reduces bad flavors from the uncooked seasoning. One of the seasoning ingredients is leek. Zhang et al. reported that the peak formation of leek oil flavor occurs at 140–165 °C [31]. At this temperature range, the burnt, fried, oily, and salty flavors from leek oil are enhanced. The content of organic compounds such as furanes, furanones, aldehydes, and alcohols and compounds containing sulfur increases during the heating process due to interactions between carbohydrates, proteins, and fats, and due to degradation of sugar, amino acids, and fats [31].

The meat is boiled in water until tender before the seasoning is added. The flavor is adjusted by the addition of salt and sugar. The cooking process is stopped once the flavor is adjusted and the meat is tender. The taste of the broth is primarily determined by nonvolatile compounds, such as free amino acids, peptides, amines, proteins, sugar, organic acids, and nucleotides [32]. A longer boiling process increases the protein degradation from the meat which allows the water-soluble components to be dissolved in the broth. During the boiling process, solid matter slowly migrates from the meat into the water, thus increasing the concentration of total solids in the soup. Soluble substances, such as glycogen, collagen, minerals, and amino acids, will migrate faster. The content of total lipids and sugar increases as the cooking time increases; however, the amount decreases after 4 h of boiling. This decline is probably due to the reaction of sugar with other components such as quercetin or the formation of Maillard reactions with other amino acids [33].

Rawon usually is cooked in a large amount and is served while hot. It can also be stored and reheated before serving. People believe that the flavor of Rawon gets better after reheating several times. The better flavor is probably due to the formation of free amino acids and low-molecular-weight peptides during the reheating process. It could also be due to the interactions between the meat derivative components and the spice components, which produce more complex new aromas or flavors and start the Maillard reaction that gives specific flavors. Repeated heating also causes more of the fiber components of the meat proteins to denature and to form colloids and causing the broth to become thicker. The colloids produced from the repeated heating can absorb flavor and aroma [4].



Fig. 5 Rawon (at the center) with its condiments and side dishes from top-right, clockwise: *kerupuk* (crackers/crisps), fried tempe, *sambal* (chili paste), mung bean sprouts, steamed white rice, *mendol*, and salted eggs. Note: own work

The presentation of Rawon

As a soup, Rawon is commonly served hot. Rawon is usually served with steamed white rice, called *Nasi Rawon* (Fig. 5), where the soup can be mixed with the rice or served separately, depending on preference. Toppings that are commonly used as condiments to *Nasi Rawon* are mung bean sprouts, *sambal* (chili paste), *kerupuk* (crackers), and fried shallots. Other side dishes that are commonly presented on separate plates include fried tempe, *mendol*, salted eggs, *empal* (beef jerky), and various deep-fried internal organs such as lungs, tripe, heart, lymph, and intestines.

The condiments for Rawon

Mung bean sprouts

The mung bean sprout used for the topping of Rawon has a short stem. The process of growing the sprouts is by soaking mung bean seeds in water overnight (12 h) and germinating in the dark for 24 h to form a 1–2 cm length root. The mung bean skin is separated from the sprout by soaking in water and gently squeezing or stirring. The sprout has a semi-sweet flavor with high water content and crunchy texture that gives a perception of a more delicious and fresher taste to Rawon. The short-stem mung bean sprouts also have good health benefits. Mung bean sprout germinated in the dark for 24 h contains 28.0% proteins, 1.4% lipids, 2.1% ash, and 68.5% carbohydrates [34]. The short-stem mung bean sprout also contains total phenolic (1.84 mg FAE/g), total flavonoid

(0.79 mg RE/g), antioxidant activities (DPPH scavenging 49%), 1.8% fiber, 4.13% total sugar, 13.2 mg/100 g vitamin C, 61 µg folate, 21 IU vitamin A, 0.10 mg/100 g vitamin E, 33 µg/100 g vitamin K, and isoflavones and flavonols minerals [35]. Traditionally, people believe that mung bean sprouts have the properties of increasing fertility.

Sambal

Sambal is added to *Nasi Rawon* to give spicy flavor to increase appetite. The amount of *sambal* added to a plate of *Nasi Rawon* is usually one teaspoon; however, some would add more or less depending on the spice tolerance of each person. The type of *sambal* added to *Nasi Rawon* can be with or without shrimp paste. *Sambal* without shrimp paste (called *sambal cabe*) is usually made of boiled chili and ground into paste by adding salt, sugar, and water. For shrimp *sambal* (called *sambal terasi*), fermented shrimp paste (*terasi*) is added. The fresh *sambal terasi* made by Cheok et al. consisted of 55% cayenne peppers, 14% bird's eye chili, 17% fermented shrimp paste, 7% sugar, 2% salt, 4% calamansi juice, and 1% citric acid, contains 181.55 mg/100 g total phenolic and capsaicinoids content (22.34 mg capsaicin, 5.98 mg dihydrocapsaicin, and 31.88 mg nordihydrocapsaicin in 100 g dry mass). The main volatile components detected in *sambal terasi* include terpene, limonene, and 3-methylbutanoic acid which are responsible for giving fresh, sweet-and-sour, and cheese flavors. Two other main volatile components found in *sambal terasi* are aldehyde and alcohol, which are responsible for giving the chili flavor [36].

Kerupuk

Kerupuk is a ubiquitous dry snack commonly added when eating a meal in Indonesian culture. There is a saying that an Indonesian meal is not complete without *kerupuk*. *Kerupuk* has existed in the island of Java since the ninth or tenth century, as written in the *Batu Pura* Inscription, and subsequently spread to other coastal parts of Indonesia such as Borneo, Sumatra, and the Malay Peninsula. *Kerupuk* has various flavors, depending on the main ingredients used [37]. *Kerupuk* commonly eaten together with *Rawon* is *kerupuk udang* (shrimp crackers) and *kerupuk uyel* (tapioca crackers). On average, consumers require 1–3 *kerupuk* when eating a plate of *Nasi Rawon*. *Kerupuk* is generally made of flour with high starch content. Besides flavor and color, one of the parameters that determines the quality of *kerupuk* is the crunchiness. Starch plays a role in determining the puffiness of *kerupuk*, as well as its color and flavor [38].

Kerupuk uyel is the most commonly available *kerupuk* made of tapioca starch with the shape of a curly noodle, crunchy texture, white color, and savory flavor, and can be purchased at a low cost. *Kerupuk udang* is made

from tapioca starch and fresh shrimp as the main ingredients. The fresh shrimp content in the ingredients varied between 3 and 60% depending on the desired quality of the *kerupuk udang*. The more shrimp used, the quality and the price of the *kerupuk* are also higher. Because of the addition of shrimp, *kerupuk udang* is more savory, but also more expensive than *kerupuk uyel*.

Fried shallots

Fried shallots are a condiment commonly added to steamed rice or broth to enhance flavor and appetite. One-half to one teaspoon of fried shallot is usually added to a serving of *Nasi Rawon*. Fried shallots are made of shallots that are skinned, thinly sliced, and fried. A small amount of flour or salt sometimes is added to the sliced shallots before frying to improve crunchiness. The savory aroma and flavor are obtained during the frying process as the result of the Maillard reaction. Fried shallots of good quality are not coated with flour, have a golden-brown color, are whole sliced instead of broken sliced, are crunchy, and have savory taste and sulfur aroma [39].

Additional side dishes

Fried tempe and mendol

Tempe is a protein-rich food that has existed since the 1700s in Indonesia. Tempe is produced from soy (or other beans) that is fermented using the microbes *Rhizopus* sp. Tempe is a nutritious and healthy food [40]. During the fermentation of tempe, there is an increase in the content of free amino acids, iron, vitamin B complex, isoflavones, and superoxide dismutase (SOD) enzyme, and a decrease in the content of antinutrient compounds phytic acid and oligosaccharides. Tempe is also known to reduce diarrhea, lower cholesterol biosynthesis, prevent the oxidation of LDL cholesterol, and prevent cancer [40].

As a side dish for *Rawon*, tempe is usually deep-fried. Fried tempe is made by marinating the sliced tempe with salt and crushed garlic, and then fried until golden brown. *Mendol* is a specialty from Malang, East Java, that is made of tempe [41]. *Mendol* is prepared from mashed tempe with seasoning paste (garlic, shallots, coriander, galangal, aromatic ginger, chili, sugar, and salt), then rolled by hand into an oval shape and deep-fried. Tempe and *mendol* taste best when eaten immediately after frying, while they are still hot. As a side dish for *Rawon*, consumers usually add 1–3 pieces of tempe or *mendol* to every serving of *Nasi Rawon*.

Salted eggs

Although salted eggs originated in China, they have become a staple in traditional dishes in Asian countries including Indonesia. Salted eggs are made of duck eggs salted by soaking in (seasoned) brine until the desired

amount of salinity is achieved, then boiling the eggs to cook them. Salted eggs can also be made by coating the duck eggs with a batter mixture of husk ash, brick powder, or soil with salt for 10–15 days, then washing and boiling the eggs to cook. The salted egg has a salty and savory flavor, with an oily yolk. The particles of egg yolk, plasma, and granules are disrupted at the end of the salting process, liberating their constituents such as phospholipids, neutral lipids, and proteins which then randomly formed aggregates. The salting process with NaCl changes the structure of the egg yolk protein, especially the structure of the low-density lipoprotein, which causes oil exudation from the yolk, while the granules cause the hardening of the yolk [42]. One or two halves of a salted egg are commonly served with Rawon.

The serving of Rawon at special events

Nasi Rawon with its side dishes and condiments can be served as breakfast, lunch, or dinner at homes or at restaurants. In addition to being a daily menu item, Rawon is also commonly served in banquets for various traditional events held by the communities, especially in the area of East Java [1]. Rawon may be served in the family or social gatherings, weddings, circumcision ceremonies, traditional or religious gatherings such as *tahlilan*, and other formal events. In a wedding party, the presentation of food is considered as honoring the guests. The food comes in wide variations from finger food, heavy meals, vegetarian dishes, dry food, or sweet snacks. Although wide variations of food are provided at a wedding party, one of the most beloved traditional foods that people always go to is *Nasi Rawon* [43]. The circumcision ceremony in Indonesia is considered a manhood ceremony for young boys. A boy is commonly considered an adult when he reaches the age of 14 years old. *Tahlilan* is a religious service commonly held for seven days at night from the day a person passed away. The grieving family will provide snacks or a rice meal [44]. One of the dishes that is appropriate to be served in those three events is *Nasi Rawon* since it is a meat-based dish. Moreover, serving *Nasi Rawon* is preferred due to its efficiency. Rawon can also be served as an option in culinary tours for tourists who want to taste Indonesian specialties when visiting certain areas.

Conclusion

As a specialty dish from Surabaya characterized by its deep black color and deep flavor, Rawon's delightful flavor is recognized not only locally, but also internationally. The meat and various spices used as main ingredients in making Rawon supported by the cooking process which involves various chemical reactions make Rawon not only highly nutritious but also have a distinctive savory flavor. Because of this advantage, Rawon is often served on many

occasions from daily menus at home to special events nationally and internationally. Aside from its delightful flavor, Rawon, which has been around for over a thousand years, also has high cultural and philosophical values.

Abbreviations

UGM	University of Gadjah Mada
UNPAD	University of Padjadjaran
SME	Small and medium enterprise
ASLT	Accelerated shelf-life testing

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Author contributions

ESM was involved in conceptualization (lead); visualization (lead); writing—original draft (lead). BSM helped in conceptualization (equal); writing—original draft (lead).

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Availability of data and materials

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All authors approved the manuscript and this submission for the Journal of Ethnic Foods.

Competing interests

The authors declare no competing interests.

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