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An Overview of Tempeh as A Polyphenolic Cuisine in Javanese Well-being Practice

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ABSTRACT

This paper explores the Javanese well-being tradition through the culinary culture of Wonogiri, focusing on the daily consumption of tempeh as both a staple food and a form of local cultural knowledge. In Javanese society, tempeh reflects inherited culinary practices, traditional fermentation skills, and values related to health and well-being. This study traces the historical roots of Javanese food culture through translated ancient manuscripts and inscriptions mentioning food practices, soybeans, fermented products, and the development of tempeh in Javanese culinary traditions, including its documentation in Serat Centhini. Tempeh is known to contain high levels of polyphenolic compounds, particularly flavonoids, which contribute to its nutritional value. Furthermore, this paper proposes the concept of polyphenolic cuisine and explains why the cuisine of Wonogiri fulfills its characteristics through the central role of tempeh in the local diet. The discussion integrates cultural-historical analysis with nutritional perspectives by examining phytochemical components such as Pyrroloquinoline quinone (PQQ), Coenzyme Q10, and iron–copper balance that may support well-being. The findings highlight the interrelationship between Javanese culinary heritage, local knowledge systems, and health-oriented food practices.

Keywords: Flavonoid, Polyhenolic cuisine, Polyphenol, Tempeh, well-being

INTRODUCTION

Many aspects of the ancient Javanese cultures and traditions until today remain enigmatic. Even as tangible as food, compared to other Asian countries, Indonesian and in particular Javanese foods seem pretty distinct and require certain understanding or conditioning in order to enjoy them as the local would. Thus, the establishment of a particular discipline such as Javanologi is considered to be relevant for a deeper understanding and comprehensive study of the culture and the traditions for various aspects, such as folk or traditional well-being system which in esoteric approach will include the model of being or man, lifestyle both spiritual and physical, climate in certain historical period for a theoretical establishment of pandemic, natural disaster and the quality of flora and fauna, including the taste of the food, as well as the type of microbiome that dominate the ecosystem at a given time.

The latter will influence many well-being aspects of the populations.

The Javanese culture and tradition can be categorised as esoteric. Hence, its mastery requires the so-called tacit knowing[1], including for the understanding of the aspect of diet and food culture., which in the Javanese context, tempeh is a good example for many not automatically find the taste palatable and or comparable to the taste of animal protein despite its glutamic acid content. Theoretically, adaptation or conditioning might be needed in order to adopt tempeh into daily staple (Shurtleff & Aoyagi, 2011). Especially when it is over fermented and still edible and believed by the locals that the such tempeh may increase their vitality. Indeed, over fermented Tempeh are eaten by some Javanese, such as in the region of Wonogiri. A region with a demanding topography and dry and humid climate, where limited plants can be grown year-round and limited access to water, especially prior to the era of Gadjah Mungkur Water Dam development. Tempeh might have contributed to the vitality of the population in the region to withstand such a demanding life condition.

Since tempeh is plant-based and rich in polyphenols, this work explores not only its nutritional properties but also its place within Javanese culinary traditions and cultural food practices. In Javanese society, tempeh has long been consumed as a daily staple and represents a form of local knowledge related to fermentation, food processing, and the utilization of plant resources. This study therefore examines how tempeh evolved within Javanese culture and how plant-derived ingredients and their secondary metabolites became embedded in local dietary traditions. Establishing the characteristics of Javanese cuisine is important for understanding the relationship between culinary heritage and community well-being. Given the abundance of polyphenol-rich plant ingredients commonly used in Javanese food, this study proposes that Javanese cuisine may be understood as a form of polyphenolic cuisine. If this concept can be established, it may help explain how long-standing food practices contribute to well-being. In particular, the prevalence of flavonoid-rich foods may theoretically be associated with a lower occurrence of allergy-like symptoms among the population (Munasir & Muktiarti, 2013).

While food is an aspect which is dominant and ubiquitous in most cultures and civilisation for enjoyment, indulgence and nourishment. However, globalisation has made traditional food become ubiquitous and many ethnics foods become available worldwide. Tempeh is not an exception to this phenomenon, despite its rarity to be found as a ready dish in many restaurants outside of Indonesia, as an alternative to meat for the vegan and plant-based individuals. This is understandable since tempeh is a fermented soy food with rich flavonoids constituent which are specifics for hormonal synthesis, namely genistein and daidzein, in particular for its role in the production of S-Equol[2] which its

[1] It is a theory developed by Michael Polanyi and delivered on a series of lectures in 1966. This theory enables the unexplainable such as esotericism to be easily understood and upon what condition the understanding and the knowledge need to conditioned. The basic structures require two things or two kind of things (Polanyi, 2009).

[2] Serum S-equol is a soy isoflavone metabolite, particularly daidzein which is produced by gut microbiota with higher bioavailability, stronger oestrogen and antioxidant effect and stronger bone density. Hence, its role in skeletal health is central to avoid osteoporosis (Cao et al., 2026; Sekikawa et al., 2025). Also, other than that, S-

production depends on individual microbiome metabolism. These flavonoids and soy phytoestrogens have made tempeh notoriously known as phytoestrogenic plant food along with its misconception for health and disease. Apart from its phytoestrogenic effect, tempeh particularly is a high histamine food due to fermentation, while soy in general is known to be allergenic.

The Javanese, especially people in Wonogiri, consume some allergenic foods such as soy, sesame and peanuts without a rampant allergic reaction as it is found in western countries, in particular the United Kingdom[3]. Restaurants in the United Kingdom will ask their clients upon being seated whether they have allergic reactions to food or not as a standard operating procedure. A food order with preference of non-gluten food will be followed by further questioning about food allergies. The latter account for more than 30% incidents of anaphylaxis shocks in the UK and mostly those are teenager below 15 years old (Bassegio Conrado et al., 2021)[4].

While the prevalence in Indonesia is accounted around 0.5 - 7,5 % of children (Augustine, 2025), less than the average statistics of World Allergy Organisation (WAO) around 10 - 40% prevalences. This data indicates that despite allergenic, the Javanese can handle the protein in tempeh, peanuts and sesame with less occurrences of allergic reactions, despite peanuts are considered as the major contributor to food anaphylactic shock.

What seems to be allergenic for a population might be different for other. As Javanese can enjoy three most potent allergenic food such as soy, peanut and sesame without significant allergic reactions, the population found that sea foods, fish, eel, egg, chicken, duck and Muscovy duck, grasshopper, alate, snail, mango and tofu are instead very allergic to them (Azizah et al., 2023)[5]. The section of food history describes the type of foods eaten by the ancient Javanese to understand the variety of foods and animal protein eaten by the ancestors and its significance to the adaptation amongst other things towards the allergic reactions. As it is seen in the list (Zulfi Azizah, et.al, 2023), tofu or unfermented soy is allergic even to the Javanese.

The list of allergenic food above, many are under the category of high histamine foods, especially sea foods. Under Mast Cells Activation Syndrome (MCAS), various foods compounds such as histamine and polyphenol may trigger a reaction similar to anaphylactic (Castells et al., 2024). Tempeh as high histamine food may not be tolerated by those under MCAS, despite being categorised as healthy food. Ditto the Polyphenol. Those three foods above are rich in polyphenol. However, only tempeh is polyphenolic, phytoestrogenic and histamine rich due to fermentation. This makes tempeh peculiar for many as a food staple, not only for the taste, but also for the physiological responds under

equol also contribute positively to cardiovascular health as thew most anti-atherogenic substance, hence it has the potential to ameliorate or attenuate dementia or intellectual decline. (Sekikawa et al., 2019).

[3] https://www.allergyuk.org/about-us/media-centre/statistics-and-figures/

[4] (Bassegio Conrado et al., 2021). Food anaphylaxis in the United Kingdom: analysis of national data, 1998-2018. *BMJ (Clinical research ed.)*, *372*, n251.

[5] The allergic reactions from high histamine foods such as mentioned above, could also be categorised as histamine intolerance and in severe case might be considered as Mast Cells Activation instead of true established allergic reactions.

certain health conditions.

This work will focus in exploring Tempeh as part of Javanese daily well-being practice from the points of view of polyophenolic cuisine with an example of dishes in the region of Wonogiri. This work intends to introduce, propose and define the concept of polyphenolic cuisine, its basic characteristics and aspects of the ingredients and the cuisine for general well-being as well as providing some examples of ingredient and dishes by taking example from the cuisine of Wonogiri.

METHOD

This is a multidisciplinary approach — descriptive, analytical and theoretical work through literature studies using the translated Javanese old text for tracing the food history in Java indicated through terminology of foods mentioned in the texts, until the period of tempeh being known. The nature of the data is both secondary and primary. The latter is through personal experience as the member of the ethnics who was brought up in Wonogiri and cooked some of the foods mentioned in this work. While the secondary data are the literature studies, especially for inscriptions and for concepts and theories in defining the polyphenolic cuisine as a proposed cuisine concept for both the Javanese and Indonesian cuisine.

This study employed a qualitative approach combining textual analysis, historical interpretation, and ethnographic perspectives to examine *tempeh* as a cultural and polyphenolic cuisine in Javanese well-being practices. Rather than relying solely on conventional research paradigms, this study also adopts the perspective of Javanese methodology, which emphasizes that cultural phenomena should be understood through the worldview, values, and knowledge systems of the community that produces them (Wirasanti, 2022). From this perspective, traditional food is regarded not merely as a nutritional object but as a cultural text that embodies ecological adaptation, local wisdom, ethical principles, and collective memory. Accordingly, *tempeh* is interpreted as both a dietary practice and a cultural heritage embedded in the Javanese conception of health and well-being (PUI Javanologi UNS, 2021).

RESULT AND DISCUSSION

Food in the Javanese Literatures

As in most ancient civilisations, historically speaking, food and life style are aspects which can be traced back to some inscriptions. So does with the Javanese life style and the foods that surrounds it. The aspect on food history can also contextualise how the Javanese people adopt and incorporate elements of cultures different than theirs into their daily habits. This is also an inquiry to what kind of messages, lessons and direction the Javanese people need to adhere to:

the old, the medieval or today's Java?[6]

This section focuses on the available interpretations of inscriptions from Central Java and surrounding regions. Rather than conducting a philological re-reading of the inscriptions, this study utilizes existing scholarly interpretations to examine references to food and food-related practices. The novelty of this work lies in the recontextualization of these findings by relating food references to broader cultural and lifestyle aspects reflected in historical sources. Food-related information found in inscriptions can provide insights into everyday dietary practices, the use of local agricultural resources, and social activities associated with food consumption in Javanese society.

Serat Centhini is a major Javanese literary work that was composed in the early nineteenth century during the reign of the Surakarta court, particularly under the patronage of Crown Prince Adipati Anom (later Pakubuwana V). The text is generally considered to have been completed around 1814–1823, making it one of the most important classical Javanese manuscripts documenting cultural, religious, and everyday life practices of the period (Ricklefs & Florida, 2012). Written in Javanese macapat poetic form, the manuscript reflects a rich synthesis of knowledge, including literature, philosophy, religion, and culinary traditions. Today, various manuscript copies of Serat Centhini are preserved in several major collections, including the National Library of Indonesia (Perpustakaan Nasional Republik Indonesia), the Sonobudoyo Museum in Yogyakarta, and the Mangkunegaran and Surakarta palace manuscript collections. In addition, references to Centhini manuscripts can also be found in established Javanese manuscript catalogues, such as those documenting collections in Dutch and Indonesian archives. These preservation sites indicate the significance of Serat Centhini as a classical Javanese source that continues to be widely studied in the fields of philology, cultural studies, and Javanology.

This perspective is particularly evident in Serat Centhini, which offers a rich description of various aspects of Javanese life. References to food in the text not only document culinary items but also reflect local knowledge, household practices, social interaction, hospitality, and concepts of well-being embedded in Javanese culture. Through these sources, food can be understood as part of a wider cultural system that connects health, social relations, and daily life. However, this study does not elaborate on the relationship between food and the extensive discussions of eroticism found in Serat Centhini, although such connections may be explored in future studies, particularly in relation to phytoestrogen-rich foods.

[6] On the part of questioning which part of the Javanese culture is being talked about. The one which is dead, as in the Old Javanese? Or today's Javanese which is evolving and subjected to changes.

In addition, currently specific ancient spiritual approach such as Yoga gains a new reading and interpretations through some critical works done in transcription and reinterpretation of some ancient sources. The author finds that such efforts provide a significant redirection and or reshaping towards the phenomena of Yogic practice in esoteric cultures such as Java and the foods which are mentioned within the text may provide context about the life style at large. Though understanding the spiritual aspects especially through Yogic practices is not the focus of this work, the Author finds the term Yoga is mentioned in the texts. More than that, there is also a description on the physical look of the King Sanjaya[7]. Foods and physical appearance are tightly related as food and eroticism or food and spirituality.

However, the sources cited in this work, do not indicate food as medicine or as the primary tool and substance to health[8]. Further on the type of foods consumed in the Old Javanese era, the society seemed to consume variety types of animal proteins. Beside those mentioned above, eggs (*hantiga*), fishes such as gourami, *kadiwas*, and *bilunglung*. *Mantyasih* I inscription mentioned wild boar (*wok*), goat (*wedus*), shrimp (*hurang*), and eggs (which is referred as *hantrini*, instead of *hantiga*). There is also a reference to a palm sap (*Jenu*), a fermented (alcoholic) beverage which is known as *tuak* inscribed as "t*uak Len sangka ing jnu*".

Other inscriptions describing foods in the Old Java are Taji (901 CE), *Panggumulan* (902 CE), *Mantyasih* I (907 CE), *Rukam* (907 CE), *Watukura* I (902 CE), and *Linggasuntan* (929 CE). However, the nature of such inscriptions and literature in the given era, are only showing fragmented informations on the foods and drinks taken by the Javanese. Rice had been the staple for the ancient Javanese, and referred as '*wras* 'in the *Taji* inscription. Consistent with the details provided in the *Negara Krtagama*, animal protein was dominant in the diet, such as *Hadangan* (water buffalo), *hayam* (chicken). Interestingly, preserved salted meat (*Deng Sin*) was also consumed despite the availability of fresh food due to climate and seasons. In the *Panggumulan* and *Rum* inscriptions also mentioned salted fish such as snapper, *kadiwas* or today's *Bawal* (Pomfret fish) and *layar -layar* (sailfish) and other dried sea food such as shrimp and crab which remain relevant in today's Javanese cuisine.

[7] In one of the accounts of Sanjaya inscription (732 C.E), there is a description of Sanjaya as a King who leads with justice (*nyãya*) and his physical appearance is in the colour of gold with large arms and thighs, and tall. One of possible explanation. from this historical elaboration is: the Javanese during the Sanskrit era (5th - 9th centuries) was agricultural society rich in grains and goldmines. Despite limited references to foods during those times, the description of Sanjaya's large arms and legs as well as being tall may indirectly indicate the type of foods and metabolism that may take place in the Javanese physiology during the time which is consistent with the description on grain and or barley (as Java is often etymologically described). See Pollock.

[8] As described extensively in the Greek-Romans empire materials, in particular under the influence of Galen's works, as described in *Alimentazione e Cultura nel Medioevo*, in the chapter *Cibo e Salute: "Cibo, dieta, farmaci; Il ciao é la prima medicina…*" (Montanari, 2024)

Niken Wirsanti describes the foods similar to the above inscriptions in relation to sima ceremony. However, the account on vegetable dishes needs further clarification in what aspects the slaughtered two cows and a goat related to vegetable dish. What perhaps significant in the description is the number of the people and the amount of the food provided during the feast: 6 *kadut* of rice, 6 buffalos and 100 chicken for 592 participants. While the traditional wedding ceremonies in Javanese modern society, as an example in the region of Wonogiri, usually provided only one buffalo for the three days feast regardless of the number of guests. Presumably those foods are mostly consumed by the participants despite the offerings, it may indicate the microbiome competence of the Old Javanese people to digest and metabolise a huge amount of foods which often a necessity where alcohol is consumed simultaneously. Both the inscriptions dated from 9th century Java to the era of Majapahit, mentioned the agricultural aspects, including the irrigation system during the period of Old Java.

Based on the list of today's allergen types described in the introductions which the Javanese are prone to, compared with the food types eaten in the Old Java era, the physiological adaptation theoretically should have taken place long enough to ensure the fitness of the organism in metabolising the allergens which in Ayurvedic term is categorised as '*kaphagenic*' or heavy to the digestive system. Indonesia's humid climate, may permits Indonesians today's indulgences in heavy, hot and spicy foods as a method to balance the *gunas*[9]. Though, the central Javanese prefers a rather sweet and agreeable taste[10], especially in the region of Wonogiri and the surrounding. However, the organic evolution assumed above seems not applicable in the case of allergic incidents in today's Java, which may indicate certain globalised life style or factor may interfere with the so-called organic adaptation and evolution. This supports the notion that flavonoids rich foods are less allergenic and those which are allergenic as soy, fermentation alters the allergenic properties as indicated in the introduction section which mentioned tofu as Javanese being allergic to, but tempeh.

Indonesia's tradition does not classify food in the manner as Ayurveda does despite the term '*guna*' was referred to in the *Nagara Krtagama* as *sad guna* or six main characteristics (Riana, 2009) In spite of certain levels of cultural influence from the Indian continent, the Javanese seemed to interpret and adapt accordingly to what suitable for them and then simplify

[9] The concept of Guna is also mentioned in the Dharmasastra Patanjala with description on the nature of Sattva, Rajas and Tamas (Acri, 2011). Guna is defined as quality; subordinate or constituent part; attribute, characteristics or property of all creation (not only food or produce) which according to *sankhya* and yoga philosophy they are contained in the *Prakriti* (cosmic primordial matter or substance) in three different aspects called *guna*: *sattwa* (pure, calm), *rajas* (stimulating, dynamic) and *tamas* (heavy, passive). They relate directly to the human character; further see: Sanskrit Glossary of Yogic Terms, Yoga Publication Trust, Munger, Bihar, India

[10] the concept of agreeable food is mentioned in Yogic texts such as Hatha Yoga Pradipika that refers to the modern-day bland taste from the points of view of Food Industry blissful scale.

the practice. A transculturation process.[11] which according to Pollock's Sanskrit cosmopolitanism, is a process which in Java is considered distinct[12]. In Java, all the 250 inscriptions are considered as royal documents. However, post Sanskrit cosmopolitanism, what can be found in the 12th - 13th centuries *Nagara Kertagama* about food and diets are some passages to a feast where foods are provided by the *Nagari* (central government) to *desa* (regional and local authority) which mentioned the ethics or *niyama* of foods for the royals that concerned with animal consumption: the type of the dishes are lamb, ox, birds, deer and bees as well as fish and eggs which consumption is according to the *Loka Purana's* rule or traditional habits. While canine, donkey, worms, rats and frogs are forbidden. Any violation to these rules will cause humiliation by enemy and causing short life (353).

There is also a mention about delicious foods for public, variety of meats from the animals who live on the soil and in the water (354) where the forbidden animals are provided due to the differences in the nature of the people in various regions, the king supplied the foods according to their liking (Riana, 2009), *twas* or alcoholic drink from coconut sap, palm or arenga sap, *brem* (dried fermented black glutinous rice water) rum like sugar cane fermented drink, rice wine (356). The generosity of the alcoholic drink supplies was also described as plentiful, free flowing like a flood, free to drinks as one likes it, until the drinker confused, fainted, nauseated and throwing up (357). However, it needs to be investigated further whether the references above, especially concerning the alcoholic drinks is related to the visit of foreigners from *Jambu Dwipa*, *Cambodia*, *China*, *Yawana*, *Campa*, *Karnataka*, *God*a, *Siangka* (Siam) to various regions in Java (326) and the drinks are offered in accordance with being courteous or drinking was indeed part of the indigenous habit of the era.

The two propositions on high animal protein consumptions and alcohols and the inscriptions cited above rise an inquiry on different dietary practices amongst those who lived in *Negara* with those who lived in *Desa,* as today Wonogiri theoretically was a unit of *desa*. This is a feature which in today's food practice remains relevant: food for the elites and foods for the poor or for the rests.

*Negar*a is a concept of today's capital, centre of culture and civilisations, while *desa* is the regions surrounding the capital. The description on *sīma above,* on Javanese spatial

[11] See Pollock (1996).

[12] Some distinctive features are: a large number of official titles in the documents are non-Sanskritic, general aesthetics, and a striking *mãhãtmya* or any reference to a majestic, magnanimous quality or some merits of a holy place or objects or peculiar efficacy of virtue of any divinity or sacred shrine. In the Javanese case, it is a reference to Java as an incomparable island (*dvipavaram yavãkhyam atulam*). The distinction also applied to the fact that despite having a sufficient mean and method of literacy through what Pollock described as belly-shaped old Javanese alphabets, the Javanese royals were willing to adopt Sanskrit as part of their literacy. Ibid.

meaning and allocation mentioned all those referred inscriptions along with the concepts as village boundaries. Village is translated as *desa* in both Javanese and Indonesian and a Javanese adjective pronounced as '*ndeso*' in today's use, means a characteristic of a person who lacks in modern or affluent way of doing things as well as lacking a refinement, education, and sophistication. It is akin to a backwardness, which is in the context of *Nagari*, it is lacking in the quality of being an *Arya*—a concept of nobility, spiritual, polished, educated and literate. Hence, the inscriptions where foods are referred above may indicate the types of foods eaten by the villagers, rather than the diet of the royals. However, this assumption needs further investigations.

From the end of the Sanskrit Cosmopolitan era around 9th century to the golden period of the Majapahit empire to the colonisation and Islamisation era of the Mataram Kingdom, different type of foods was found in Serat Centhini, namely Tempe or fermented soybeans and or *kadhele* (Bronkhorst, 1996).

There are some mentions regarding the dishes involving tempe or soybeans, such as *brambang jae santen tempe.. asem sambel lethokan*," and in the chapter 12 "*..kadhele tempe srundengan*[13] , a reference dated around 1815. However, there is a possibility that tempeh had existed since the 1600, during the reign of the Sultan Agung. While the word soy (*kedelai* or *kedelé*) had existed in Java since the 12th or the 13th centuries from the serat Sri Tanjung manuscript. Hence, the word '*tempe* 'is considered to be Javanese or Indonesian origin and not Chinese origin as in *touci*, *tauco*, *taugé, Taujjang*, *tahu*, and *takua in*.

From the description above, the polyphenolic nature of Javanese cuisine can be identified through references in Serat Centhini to tempeh, brambang (shallot), jae (ginger), and asem (tamarind), all of which are known to contain high levels of flavonoids. Beyond their phytochemical properties, these ingredients hold an important place in Javanese culinary traditions. They are widely used in daily cooking, traditional recipes, and food preparation practices that have been transmitted across generations. Shallots, ginger, and tamarind are essential components of Javanese seasoning and flavoring systems, while tempeh represents a distinctive form of local fermentation knowledge and serves as a staple source of nutrition for many communities. Their frequent appearance in historical sources suggests not only their dietary significance but also their role in shaping local food identities and culinary practices. Taken together, these ingredients contribute to what may be described as a polyphenolic cuisine, characterized by the integration of plant-based foods, spices, and fermented products

[13] https://www.geonusantara.org/2017/10/27/tempe-tertulis-dalam-naskah-sejarah-indonesia/

within a coherent cultural food system. However, the question of how fermentation technology developed in Java remains important. Although the emergence of tempeh production may have involved coincidental processes, the history of soybeans and soy fermentation may provide valuable insights into the evolution of fermentation knowledge in Javanese society.

Soy History

Soy is considered to be originated in China (The Great Soviet Encyclopedia, 1926-90), circa 5000 years ago. However, an archeological site in Korea preserved what is known as the oldest dots beans dated around 10,000 BCE. A reference to China as the place of origin often referring to its cultivation around 3000 years ago, which China is often famous for. Only by the 6th century Chinese Buddhist monks took soya beans to Korea and Japan. Silk Road traders spread them to Southeast Asia[14]. It is considered as Asia's classic condiment and first made in China around 2000 years ago. Its introduction to Japan was due to introduction of Buddhism whose monks also brought with them some foods and condiments, one of them is the soy sauce. By 1558, a clear soy sauce was made near Edo.

On how the Javanese adopted the fermentation technology for both and tempeh, Author assumes require a further investigation in the nature of the Hindu and Buddhist influence in all aspects of life through the reading of Old Javanese Texts. From the description about how the soy was popularised by the Silk Road Trader to the South East Asia, needs to be confronted with the facts that Buddhist monks perhaps travelled with those traders to the Southeast Asia as it is described in the Kakawin Desa Wrnarna or Negara Krtagama. When fermentation is concerned, it is described that the Buddhist monks who brought fermented soy to Japan.

Contextual and Operational Definitions of Key Terms

Tempeh

Tempeh as a concept refers to the fermentation process on a soaked, cooked, hulled and dried ingredients such as legumes or nuts such as coconut in tempeh *bongkrek*. Today's development even adopts the technology into fermenting various grains and labelling them as tempeh, despite a fermentation process also takes place in sourdough bread making. What makes tempeh is tempeh is the fermenting agent, which includes spores' growth and the whole ingredient which makes fermentation occurs in a precooked, dried - solid and covered materials. While fermentation is a universal knowledge, presumably a form of tacit knowing that exists across cultures and traditions. Hence, the serendipity or coincidence which often

[14] The Story of food an illustrated history of everything we eat (2018), DK, Penguin Random House, Soy beans

assumed about how tempeh was engineered, could theoretically not as accidental as it has been hypothesised, when the aspects of tacit knowing is considered.

Polyphenolic Cuisine

As part of the polyphenolic cuisine concept, the traditional Javanese diet is not prioritising the domination of a particular macronutrient such as chicken breast or other type of steak-like meat. Instead, it uses variety of ingredients with concentrated phytochemical known as polyphenols. Hence, the diet somehow balanced in both macronutrient and micronutrient aspects. This section explains the two macronutrients, namely fat and protein such as coconut oil and legume. Both are polyphenolic, with legumes represents the larger polyphenol class known as flavonoids. Tempeh is an excellent example of the nutrition compact to represent this type of cuisine as well as its amino acids composition needed for particular mechanism of action.

Such cuisine is known for its ability to supply antioxidant and or enhance the detoxification effect when consumed regularly, since the cuisine focuses on strengthening the cellular mechanism where macronutrients are concerned: carbohydrate, protein and fat. Coconut oil, meat and its milk are polyphenolic, macronutrients and micronutrients. It is as compacted as tempeh when nutritions are concerned. What is unique in coconut is its fat is metabolised both ways: the carbohydrate path in the liver through the portal vein and through conventional path for fat metabolism. Hence, consuming coconut may require a healthy liver and a competence in balancing the cooling effect of coconut per Ayurvedic principles.

The term polyphenol generally is referring to a plant secondary metabolite compound, its use in the so-called polyphenolic cuisine does not make it an exclusively plant-based cuisine. This is the fundamental characteristics of the Polyphenolic cuisine, which the dominant ingredients can be both plants based or animal based. Plants, however is its primary choice of ingredients, due to its antiallergic and its anabolic tendency with around 4000 types of flavonoids from the 8000 phenols produced by plants (Twaij & Hasan, 2022; Yang et al., 2023).

The Author introduces the term Polyphenolic cuisine in this paper to refer to the properties and characteristics of the Javanese Cuisine which can be identified by at least the colour and the aroma. Taste can also be a defining characteristic of the Polyphenol cuisine. Especially when the polyphenol type is from the group of flavonoids which tend to be bitter. In this context and for the purpose of limiting the scope of the phytochemical which are categorised as phenolic compounds and polyphenol, the author focuses on flavonoids for

several reasons. First, from the polyphenol' classes[15], flavonoids[16] is categorised as the biggest class or most commonly distributed phenolic compounds amongst plants[17]. The authors adopt the definition of polyphenol based on its structural expressions as described by Stéphane Quideau (2013)[18]. Quideau stated that the classical physicochemical property based polyphenolic definition has often been misinterpreted or wrongly disregarded. It seems, the definition of true Polyphenol remains an open area to be debated, despite the tendency towards Quideau's position that require more than one phenolic ring to be considered as true polyphenolic compound.[19]

However, flavonoids ubiquitousness is not sufficient to define and characterise the nature of polyphenolic cuisine since practically, most ethnics cuisines will naturally bear some similarity with the polyphenolic cuisine style where terpenoid compounds and Sulphuric compounds juxtapose with the polyphenolic compounds within an ingredient. The strength of defining polyphenolic cuisine as identical with flavonoids dominant ingredients is due to the nature of the phenolics compounds which are often naturally many are occurring with flavonoids. Hence, by using flavonoids as the dominant compound within the ingredients, the cuisine is fit to be defined as Polyphenolic.

Hence, the ingredients and its combinations and the phenolics compounds intensity within a dish or combinations of dishes and entire dining tradition or culinary style are fundamental for the main aspects of the polyphenolic cuisine's characteristics. Presumably,

[15] Polyphenolic compounds classes are: simple phenols, benzoquinones, phenolic acids, acetophenones, phenylacetic acids, hydroxyciinnamic acids, phenylpropenes - coumarines, isocoumarines, chromones, naftoquinones, xanthones, stilbenes, anthraquinones, flavonoids, lignans - neolignans, lignins (Bravo, 1998). Bravo's definition is similar to Bartelli et al. (2021), with emphasise at least on one phenyl rings (sic) and one or more hydroxyl rings. Compare this definition to the Quideau's definition on the footnotes 8 and 9 below.

[16] Flavonoids groups are: chalcones, dyhydrochalcones, aurones, flavones, flavonols, dyhydroflavonol, flavanones, flavanol, flavandiol or leucoanthoscyanidin, anthocyanidin, isoflavonoids, biflavonoids, proanthocyanidin or condensed tannin. Amongst the flavones are apigenin, luteolin, diosmetin. While example of flavonols is quercetin, myricetin, kaempferol (Bravo, 1998)

[17] The term phenolic compounds also mean both simple phenols or phenolic acids and polyphenols. However, structurally, polyphenols contain more than one phenol (Al Mamari, 2022). Phenolic Compounds: Classification, Chemistry, and Updated Techniques of Analysis and Synthesis. In Biochemistry. IntechOpen. https://doi.org/10.5772/intechopen.98958

[18] Polyphenol are plant secondary metabolites derived exclusively from the shikimate - derived phenylpropanoid and or the polyketide pathway, featuring more than one phenolic and deprived of any nitrogen-based functional group in their most basic structural expressions (Quideau et al., 2013). The nitrogen-based group in the plant secondary metabolites is known as N - containing compounds such as alkaloids, cyanogenic glycosides and non-protein amino acids (Twaij & Hasan, 2022).

[19] Structurally, Quideau (2011, 2014) and Singla et al. (2019) are in the position that polyphenol require more than one phenyl ring and at least one hydroxyl ring. Closer to Quideau's definition is Singla's classification of Polyphenol into Flavonoids and non-Flavonoids or classifying it into many subclasses depending on the number of phenol units, substituent groups, and or the linkage type between phenol units. Interestingly, both the number of phenyl rings and the linkage type, will lead to mostly flavonoids as true polyphenol. Similar definition to Quideau states that Phenolic acid is non flavonoid and non-polyphenolic, as well the structure of flavonoids as phenolic compounds are consisted of two benzene rings connected by three carbon atoms in its basic skeleton (Yang et al., 2023).

without quantifying the intensity of polyphenol of the spices and other ingredients in the Javanese cuisine other than Tempeh alone for this article's purposes, looking at the fundamental characteristics of polyphenol structural expressions, the cuisine's flavonoids dominant is sufficient to represent the cuisine style. While a more detailed work regarding the characteristics, principles and example of the polyphenolic cuisine other than the Javanese cuisine is subjected to a separate work along with the quantification of phenolic compounds accordingly. Tempeh is chosen as the main example of flavonoids dominant in both the ingredient itself and the intensity of its use in the Javanese cuisine, especially in Wonogiri region and its surrounding.

Tempeh in the Javanese Polyphenbolic Cuisine

This section explains one aspect of the Polyphenolic cuisine, which is the main or dominant ingredient, which is tempeh for its macronutrient compositions such as fat and protein equal to any meat substitutes. Ditto tofu which is second in the hierarchy of macronutrient, despite being less superior in total flavonoids or Polyphenolic compounds compared with tempeh. Other legumes or grains which are fermented using tempeh technology, can be categorised as Polyphenolic cuisine ingredients. However, in the aspect of phytoestrogens, probiotics, and isoflavone such as genistein (Ge) and daidzein (Da), tempeh is unique in its function and position. The use of tempeh alone without additional Polyphenolic spices within a dish will make the cooking polyphenolic. Especially if compared with the unfermented soy, tempeh still provides a well-rounded nutritional profile in many aspects, for it can function as a meat substitute or main, or side dish. Certainly, the incorporation of miso, natto, tofu, *tauco* (fermented tofu), will create a better polyphenolic cuisine experience.

Polyphenolic spices are the second aspect in the primary characteristics of Polyphenolic cuisine. When spices are concerned, the Javanese cuisine and Indonesian cuisine are generally fit into such characteristics. However, this section will not elaborate further the aspects of the spices that accompanied tempeh's dishes or in general Javanese and Indonesian cuisines. Examples of the dishes provided below are intended to emphasise the centrality of tempeh in the cuisine to help others adopts the ingredient first into their daily staple to make the Polyphenolic cuisine experience and journey simple, practical and easy.

This aspect is perhaps the main set back of polyphenolic cuisine in particular. Generally, the physiological adaptation of plants compounds and its secondary metabolites many founds as quite unpleasant for those who have not been conditioned to consume a higher amount of fibres, colourful plant foods and or plant based nutritions. Hence, the allergic or

other food intolerance reactions. Usually, the most common reaction is the intense bitter taste instead of umami. This is true with flavonoids.

As it is described in the section of Soy History that incorporating soy as a food staple is demanding. Fermenting it, makes soy more pleasant and edible, despite the histamine content. Hence, as a matter of conditioning, it is easier to introduce a beginner in adapting the Polyphenolic cuisine with miso first instead of tempeh. Theoretically, mangostan or rambutan can be consumed prior to consuming powypohenolic foods. Despite no studies have ever been conducted to the significance of consuming them with the polyphenol taste enhancement and metabolism in non-plant-based eaters, this approach theoretically may provide a pleasant conditioning, especially for children who often refuse to eat vegetables. The author's personal experience with such conditioning helps to return the olfactory sensation and metabolism capacity upon dysbiosis due to changes in foods, season, and microbiome during travel or other health concerns.

As well, Author found no studies or clinical trials have been conducted in conditioning someone's microbiome profiles and compositions through those fruits mentioned above or other methods, in order to increase the numbers of beneficial microbiome in the gut and eliminate the pathogenic ones. The fruits above are known to contain the spores of saccaromyces boulardii CNCM-i745. Its mechanism of action in the humans' intestines is to bind into pathogens in order to create the right environment for beneficial microbiome to grow. Indonesians in general consume at least Rambutan and Mangostan regularly. Theoretically, Indonesians have the natural physiological conditioning through those fruits for the polyphenolic —spicy and colourful foods, without any special effort to make the polyphenol taste better to the Indonesians palate and the olfactory.

Tempeh in Wonogiri

This section describes examples of home-style cooking and several dishes along with their nutritional significance. The discussion focuses on the phytochemical properties of plant-based ingredients, particularly polyphenols, which are abundant in many components of Javanese cuisine. Although polyphenols are often categorized as xenobiotics in human metabolism, their presence remains significant in traditional food systems and may contribute to general well-being among populations that regularly consume them. In the Javanese context, the long-term use of polyphenol-rich ingredients such as spices, herbs, vegetables, and fermented foods has not only influenced dietary patterns but also shaped local cooking traditions and food preferences. The frequent incorporation of these ingredients into everyday

meals reflects accumulated culinary knowledge regarding flavor, food preparation, and ingredient combinations that have been transmitted across generations. As a result, the prevalence of polyphenol-rich foods in Javanese cuisine can be understood not merely as a nutritional characteristic but also as an integral element of cultural food practices and culinary heritage.

In Wonogiri and its surrounding, tempeh can be found in various dishes. Depending on other ingredients used in the dish, tempeh's significance for overall well-being can be enhanced. Even for the least favourable cooking method as frying, tempeh is still providing significant nutritions.

The example of the Javanese Polyphenolic dishes and its nutritional significance can be classified into macronutrient aspect in which tempeh is apparently superior, and micronutrient and or molecular aspects such as Mitochondrial[20] enhancement and its multiplications through Pyrroloquinoline Quinone (PQQ) due to fermentation[21]. Natto is considered as the richest source of PQQ. However, by taste and textures, foods such as miso, tempeh and tauco, are more delicious or rather agreeable and practical for many. Plant sources of PQQ are: cabbage, carrot, spinach (rather wild spinach or ancient amaranth), green celery, green pepper (in this case the author assumes as well green chilli) and parsley. Fruits rich in PQQ are papaya, kiwi, banana and orange[22].

The Javanese combines fresh tempeh and over-fermented tempeh (in small amount which functions rather spices-like) as well green chilli in the coconut - soup base, known as "*jangan lombok*" or tempeh - chilli soup in coconut milk. The dry version of such dish without the addition of coconut milk is known as '*oseng tempe*' or tempeh sauté. The basic principle remains in these two dishes: green chilli dominates the dish instead of tempeh or tofu or vegetables such as green papaya (*Carica papaya*) or chayote (*Sechium edule*) which can be added in these two dishes.

Other dishes with a combination of chilli with Tempeh, Tofu and spices are *Bacem* and sambal tumpang. *Bacem* can be paired with green chillis fresh and whole or in the form of garlic-sambal. *Bacem* is rather specific, since it is found only in Java and taste-wise it is sweet

[20] Mitochondria is a biological structure, part of an organelle or little organ, a specialised structure that keeps the cell functional within a cytoplasm. Its function is to produce energy known as Adenosine Triphosphate (ATP). The more the mitochondria, the more the ATP, the more energetic we become.

[21] PQQ is an organic compound which goes through an active reduction-oxidation (redox) cycle. Meaning, this benzene or naphthalene aromatic compound, also known as quinone experiences losing electrons (oxidation) and gaining electrons (reduction) simultaneously in order to balance the redox process to scavenge free radicals and maintain mitochondrial functions, multiply the mitochondrial numbers and increased enzymatic reactions. (Yan et al., 2024).

[22] for more comprehensive list and exact amount of PQQ content, please refer to: Kumazawa et al. (1995).

despite being a staple for rice. While *Sambal Tumpang* with basic ingredients are spices and tempeh, better be served hot with rice while *bacem* can be enjoyed cold, as a snack or a staple to rice.

Well-being Aspects of Tempeh in Wonogiri's Style of Polyphenolic Cuisine

The author differentiates the definition of wellness and well-being. Well-being comes from two joint words: the adjective 'well' and the noun 'being'. It literally means the state of being comfortable, healthy, or happy, or welfare, health, good health, happiness, comfort, security, safety, protection, prosperity, profit, good, success, fortune, good fortune, advantage, interest, prosperousness, successfulness. The practice of well-being is the result of the wellness habits. Well-being is a state, while wellness is an effort which may provide a temporary relief or solution. However, the effect can be compounding or exponential thanks to regularity. Hence, well-being is a form of advancement, a long-term reward and or bonus from the wellness habits done little by little, every day. Hence, in order to achieve the state of well-being, as practiced by people in Wonogiri by eating tempeh daily. Below are some well-being aspects which theoretically can be achieved by consuming tenpeh daily with some particular foods.

Mitochondrial Vitality through PQQ and Coenzyme Q10

While PQQ quantitatively increases the number of mitochondria, coenzyme Q10 (Coq10) energises and vitalises the mitochondria. Both are quinones, and soy lecithin is considered as the most effective carrier for higher absorption of Coq10. However, both PQQ and CoQ10 are limited in its availability in nature which theoretically depends on the availability and variety of soil microbiota. While CoqQ10 endogenous synthesis in cells and plants do not require soil microbiota, but amino acids such as tyrosine and or phenylalanine.

In human and animals, CoQ10 is synthesised endogenously or obtained exogenously through diet and supplementation. The latter is considered the best approach for its therapeutic effect despite the endogenous Coq10 dominates the majority of the supply needed by the body [23]. In another words, CoQ10 sufficiency to achieve any meaningful effect will require a

[23] CoQ10 shares the mevalonate pathway for its endogenous synthesis which also synthesises biomolecules amongst others, such as cholesterol and heme A. Its physiological functions such as mitochondrial energy productions, antioxidant defense and cellular stability and signalling and its ability to regenerate other antioxidants, especially vitamin E position Coq10 as fundamental in maintaining vitality and energy level. Further: Understanding COQ10: Biological roles and plant-derived sources, Abhinaya B, Thanuja B, Sai Harsha VJ and Swathi P, Raghu College of Pharmacy, Dakamarri, Visakhapatnam. GSC Biological and Pharmaceutical Sciences, 2025

thoughtful approach from the exogenous pathway, including supplementation.

The Javanese cuisine CoQ10 levels can be approximated through both animal and plant sources. The high consumption of tempeh with its high fat content along with flavonoids such as quercetin which is rich in onion or shallot, and kaempferol in ginger, theoretically will help with the higher absorption and the availability for both non animal source and animal source of CoQ10 which the culinary examples will be detailed in the copper and iron balance section below.

Foods rich in CoQ10 mostly are internal organs such as liver, heart and kidney. Plant source includes nuts and vegetable oils such as soybean oil, corn oil and olive oil[24]. The role of flavonoids such as quercetin and kaemferol are to increase the material for the CoQ10 synthesis endogenously[25].

Mitochondrial Dysfunction and Copper - Iron Balance

Tempeh's copper content is considered sufficient to fulfil the daily trace element requirements. However, the Central Javanese diet incorporates other copper rich foods as part of the staple, such as liver. Copper is a trace mineral human body needs to maintain mitochondrial functions and balancing iron overload provided the individual has no genetical predisposition that leads to Wilson or Menkes disease.

Despite copper indirect role in mitochondrial proper functioning through iron uptake, its balance is fundamental for mitochondrial respiratory mechanism that leads to energy production. Similar to quinone, copper's unique electron structure is capable of redox properties. This makes copper crucial for detoxification, especially concerning the enzymatic activities[26] and cell signalling that may lead to the so-called phenomenon of *crupoptosis*[27]. Its homeostasis is regulated by the liver, and its imbalances in both deficiency and overload are indications of health issues such as anemia, neutropenia, and thrombocytopenia.[28] While its deficiency impaired immune function and susceptibility to infection, its excess can cause neurological problem, oxidative stress, atherosclerosis and tumor[29]. Hence, its homeostasis matters and it depends on its metabolism on how much copper is supplied, absorb and

[24] The reference differentiates the Italian study and Japanese study for the Coq10 content in oils. The Italian study yields higher Coq10 contents (Pravst et al., 2010).
[25] Further: (Berger et al., 2021)
[26] Copper regulates several enzymes: copper/zinc superoxide dismutase 1 (SOD 1), cytochrome C oxidase (CCO), ceruloplasmin (CP), lysyl oxidase (LOX) and tyrosinase (Yan et al., 2024; Tsang et al., 2021)
[27] A newly found mechanism on cell death signalling due to copper, a distinct cell death signalling than apoptosis, ferroptosis (due to iron) and necrosis. (Li et al., 2025).
[28] (Ruiz et al., 2021)
[29] (Li et al., 2025)

transported, stored and eventually excreted.

The sufficiency of copper - iron balance in the Javanese diet may stem from the variety of foods, rather than the exact portion of a single macronutrient alone. This is a consistent phenomenon that can be observed in Javanese Jamu approach as well as Ayurvedic herbal formulations which focus on variety of ingredients in small doses consumed together rather than dosing a single ingredient alone. Further on this aspect is subject to a separate work in the aspect of Choline-Betaine sections, along with the aspect of spices in the Javanese Polyphenolic cuisine in its relation to hormonal focus diet for menopausal women in particular and for general well-being, especially when the polyherbalistic approach is concerned. Apart from the diet, the Javanese as well use copper cookware.[30]. However, its use is not dominant, direct or often. Hence, the main source for copper - iron homeostasis in traditional Javanese diet in Wonogiri and its surrounding come from the diet that can be seen from the examples of its culinary below:

a. *Sambal*

a.1. Fried or Sautè, such as *Sambal goreng ati - kentang* or fried beef liver *sambal*.

Rarely the People in Wonogiri and the surrounding will cook the chicken liver and the chicken gizzards exclusively bundled together as the Tegal style would or Semarang satay style which will include chicken's internal organs.

a.2. Peanut *Sambal*

Peanut sambal dominates the Javanese diet and it can deliver more than 100% copper daily need per 100 grams of peanuts. There are variations of the sambal which equally the most popular method is through frying the peanuts, then using a pestle the peanuts are made into a paste with added ingredients including red chilli, garlic, salt, brown sugar and optional is *kencur*, a type of galangal specific in Javanese cuisine (another example that uses *kencur* is the Sundanese Fried rice "*Cikur*"). Sometimes, some people will add cashew to the peanut sambal to increase the umami taste. Cashew is also a significant plant source of copper. While cashew is a nut, peanut is a legume.

a.3. *Sambal Wijen* or White sesame seed sambal

[30] Traditionally, most of the copper cook ware were huge, and they are called 'dandang, or a boiler. They are used for steaming (if another layer of tool is used, such as kukusan - a bamboo coned shape container) or boiling foods such as corn, fresh legumes such as soy-edamame in shell , peanuts in shell, rice, cassava etc. Hence, they are not used daily, unless a huge batch of foods or rice are needed to be cooked.

This one is a rarity or not a daily staple. White sesame seeds are usually found in snack in daily consumption. Usually, the *Sambal Wijen* is eaten to accompany the so called "*Pecel Gendar*". *Pecel* is a salad concept in Java with boiled vegetables and usually accompanied by peanut sambal, instead of sesame seeds sambal. However, with "*Gendar*"[31] *sambal wijen* is preferred, especially in Surakarta.

b. Dishes wrapped in banana leaf

b.1. *Arem - Arem* is the Javanese beef liver for snacks

A spicy cooked rice filled in with beef liver and vegetables and layered with a thin egg layer in outer part then wrapped with banana leaf then steamed. The taste is spicy-hot. The filling usually contains chilli and root vegetables such as carrot and potato along with the small cube cut of beef liver.

b.2. *Garang Asem*

A softer or more agreeable version where internal organs can be included in the steam small cut from the parts of whole chicken with some cut of chilli, green tomato, cooked in soft and spicy coconut milk. Rather elegant in taste and a white -coloured dish.

b.3. *Cabuk* or a type of *pepes*

It is a dish of black sesame seeds which are blended into a paste, then steamed while wrapped in banana leaf. *Cabuk* is eaten as an addition, not a dominant staple. Something similar to the role of condiment, eaten in small amount. It is considered as delicacy; hence it's not a daily staple.

Other than spices which can also be polyphenolic, those dishes mentioned above include other ingredients such as coconut milk which also contains polyphenol. However, both spices and coconut milk contributed to lipid metabolism with spices through cholinergic pathway and Coconut milk through the Octanoid acid pathway and cysteine. Both are crucial for the mitochondrial health, despite its insignificant endogenous synthesis in the physiology.

CONCLUSION

This study demonstrates that food occupies a central position in Javanese concepts of well-being, functioning not only as a source of nutrition but also as an expression of cultural knowledge, culinary traditions, and everyday practices. By examining historical sources,

[31]rice cake (with additive such as borax standardised to 0,5% and natrium trifolyphosphate standardised to 0,3% compared with the traditional additive '*bleng'* with 12% borax) to make the texture chewy. (Suher et al., 2016).

including inscriptions and *Serat Centhini*, alongside contemporary examples from Wonogiri cuisine, this research proposes and defines the concept of polyphenolic cuisine as a culinary system characterized by the frequent use of polyphenol-rich ingredients, particularly tempeh, spices, and plant-based foods. The findings suggest that tempeh is significant not merely because of its high flavonoid content and potential health benefits, but also because it represents a longstanding tradition of fermentation knowledge that has become deeply embedded in Javanese food culture. References to tempeh, ginger, shallots, tamarind, coconut, and other ingredients indicate the continuity of local culinary practices and the transmission of food knowledge across generations. The study further shows that Javanese cuisine reflects a syncretic food culture in which local resources, fermentation techniques, and plant-based ingredients are integrated into daily dietary practices. Although historical sources provide limited direct evidence regarding the relationship between food and health, they reveal the cultural importance of food in shaping social life and collective well-being. Through the case of Wonogiri cuisine, this research contributes to Javanese cultural studies by highlighting tempeh as both a culturally significant food and a practical example of polyphenolic cuisine. Finally, the study encourages further interdisciplinary research on the relationships among traditional food systems, phytochemicals, microbiomes, fermentation knowledge, and well-being in Javanese society.

REFERENCES

Acri, A. (2011). *Dharma Pātañjala: A Śaiva scripture from ancient Java studied in the light of related Old Javanese and Sanskrit texts* (Doctoral dissertation, Leiden University). Leiden University. https://hdl.handle.net/1887/16438

Al Mamari, H. H. (2022). Phenolic compounds: Classification, chemistry, and updated techniques of analysis and synthesis. In *Biochemistry*. IntechOpen. https://doi.org/10.5772/intechopen.98958

Augustine, I. (2025, October 2). *Childhood allergy cases rising in Indonesia: UGM pediatrician stresses accurate diagnosis and prevention*. Universitas Gadjah Mada. https://ugm.ac.id/en/news/childhood-allergy-cases-rising-in-indonesia-ugm-pediatrician-stresses-accurate-diagnosis-and-prevention/

Baseggio Conrado, A., Ierodiakonou, D., Gowland, M. H., Boyle, R. J., & Turner, P. J. (2021). Food anaphylaxis in the United Kingdom: Analysis of national data, 1998–2018. *BMJ, 372*, n251. https://doi.org/10.1136/bmj.n251

Berger, A., Latimer, S., Stutts, L. R., Soubeyrand, E., Block, A. K., & Basset, G. J. (2022). Kaempferol as a precursor for ubiquinone (coenzyme Q) biosynthesis: An atypical node between specialized metabolism and primary metabolism. *Current Opinion in Plant Biology, 66*, 102165. https://doi.org/10.1016/j.pbi.2021.102165

Bronkhorst, J. (1996). Ideology and status of Sanskrit. In J. E. M. Houben & S. Pollock (Eds.), *Ideology and status of Sanskrit: Contributions to the history of the Sanskrit language* (Brill's Indological Library, Vol. 13, pp. 1–23). Brill.

Bravo, L. (1998). Polyphenols: Chemistry, dietary sources, metabolism, and nutritional significance. *Nutrition Reviews, 56*(11), 317–333. https://doi.org/10.1111/j.1753-4887.1998.tb01670.x

Cao, W., Li, R., Zhang, H., Zhang, T., Pan, H., Sun, W., Wang, L., Ke, J., Petersen, J. D., & Zhang, P. (2026). Exploratory multi-omics analysis of gut microbiota and fecal metabolites in relation to serum S-equol levels in older adults with osteoporosis from a tropical community: A pilot study. *Frontiers in Nutrition, 13*, 1784894. https://doi.org/10.3389/fnut.2026.1784894

Castells, M., Giannetti, M. P., Hamilton, M. J., Novak, P., Pozdnyakova, O., Nicoloro-SantaBarbara, J., Jennings, S. V., Francomano, C., Kim, B., Glover, S. C., Galli, S. J., Maitland, A., White, A., Abonia, J. P., Slee, V., Valent, P., Butterfield, J. H., Carter, M., Metcalfe, D. D., Akin, C., & Milner, J. D. (2024). Mast cell activation syndrome: Current understanding and research needs. *The Journal of Allergy and Clinical Immunology, 154*(2), 255–263. https://doi.org/10.1016/j.jaci.2024.05.025

Glossary of yogic terms. (n.d.). Yoga Publication Trust.

Kumazawa, T., Sato, K., Seno, H., Ishii, A., & Suzuki, O. (1995). Levels of pyrroloquinoline quinone in various foods. *Biochemical Journal, 307*(2), 331–333. https://doi.org/10.1042/bj3070331

Li, Y., Han, Y., Shu, Q., Kan, Y. K., & Wang, Z. (2025). Cuproptosis and copper as potential mechanisms and intervention targets in Alzheimer's disease. *Biomedicine & Pharmacotherapy, 183*, 117814. https://doi.org/10.1016/j.biopha.2025.117814

Montanari, M. (2024). *Alimentazione e cultura nel Medioevo*. Gius. Laterza & Figli.

Munasir, Z., & Muktiarti, D. (2013). The management of food allergy in Indonesia. *Asia Pacific Allergy, 3*(1), 23–28. https://doi.org/10.5415/apallergy.2013.3.1.23

Polanyi, M. (2009). *The tacit dimension*. The University of Chicago Press. (Original work published 1966)

Pravst, I., Žmitek, K., & Žmitek, J. (2010). Coenzyme Q10 contents in foods and fortification strategies. *Critical Reviews in Food Science and Nutrition, 50*(4), 269–280. https://doi.org/10.1080/10408390902773037

PUI Javanologi UNS (Ed.). (2021). *Menggagas metodologi Jawa: Wacana, identitas, dan paradigma* (1st ed.). PUI Javanologi UNS.

Quideau, S. (2013). Plant polyphenols. In *eLS*. John Wiley & Sons. https://doi.org/10.1002/9780470015902.a0000913.pub2

Riana, I. K. (2009). *Kakawin Deśawarṇana utawi Nāgarakṛtāgama: Masa keemasan Majapahit*. Kompas.

Ricklefs, M. C., & Florida, N. K. (2012). *The birth of the Serat Centhini: The production of a major Javanese literary text*. KITLV Press.

Ruiz, L. M., Libedinsky, A., & Elorza, A. A. (2021). Role of copper on mitochondrial function and metabolism. *Frontiers in Molecular Biosciences, 8*, 711227. https://doi.org/10.3389/fmolb.2021.711227

Sekikawa, A., Ihara, M., Lopez, O., Kakuta, C., Lopresti, B., Higashiyama, A., Aizenstein, H., Chang, Y. F., Mathis, C., Miyamoto, Y., Kuller, L., & Cui, C. (2019). Effect of S-equol and soy isoflavones on heart and brain. *Current Cardiology Reviews, 15*(2), 114–135. https://doi.org/10.2174/1573403X14666180704124828

Sekikawa, A., Weaver, A., Mroz, K., Heilmann, N. Z., Madrid Fuentes, D. A., Koltun, K. J., Carlson, L. J., Cattell, K. L., Li, M., Li, J., Hughes, T. M., Strotmeyer, E., Nindl, B., & Cauley, J. A. (2025). S-equol as a gut-derived phytoestrogen targeting estrogen receptor β: A promising bioactive nutrient for bone health in aging women and men: A narrative review. *Nutrients, 17*(24), 3962. https://doi.org/10.3390/nu17243962

Shurtleff, W., & Aoyagi, A. (2011). *History of tempeh and tempeh products (1815–2011): Extensively annotated bibliography and sourcebook*. Soyinfo Center. https://www.soyinfocenter.com/pdf/148/Temp.pdf

Suher, L. S., Pranoto, Y., Harmayani, E., & Raharjo, S. (2016). *Karakteristik kerupuk karak menggunakan bleng dan natrium trifolifosfat* (Undergraduate thesis, Universitas Gadjah Mada). https://etd.repository.ugm.ac.id/penelitian/detail/101170

The story of food: An illustrated history of everything we eat. (2018). DK.

Tsang, T., Davis, C. I., & Brady, D. C. (2021). Copper biology. *Current Biology, 31*(9), R421–R427. https://doi.org/10.1016/j.cub.2021.03.054

Twaij, B. M., & Hasan, M. N. (2022). Bioactive secondary metabolites from plant sources: Types, synthesis, and their therapeutic uses. *International Journal of Plant Biology, 13*(1), 4–14. https://doi.org/10.3390/ijpb13010003

Wirasanti, N. (2022). The remnant of ancient Java as a sign system in Bagelen, Central Java. *Indonesian Historical Studies, 6*(1), 19–33. https://doi.org/10.14710/ihis.v6i1.14934

Yan, T., Nisar, M. F., Hu, X., Chang, J., Wang, Y., Wu, Y., Liu, Z., Cai, Y., Jia,J., Xiao, Y., & Wan, C. (2024). Pyrroloquinoline quinone (PQQ): Its impact on human health and potential benefits. *Current Research in Food Science, 9*, 100889. https://doi.org/10.1016/j.crfs.2024.100889

Yang, F., Chen, C., Ni, D., Yang, Y., Tian, J., Li, Y., Chen, S., Ye, X., & Wang, L. (2023). Effects of fermentation on bioactivity and the composition of polyphenols contained in polyphenol-rich foods: A review. *Foods, 12*(17), 3315. https://doi.org/10.3390/foods12173315