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Review Article

A Review on the Use of Spices in the Blending of Malaysian Curry Powder Matrix

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ABSTRACT

Malaysian curry powder is a complex spice matrix formulated to produce a characteristic balance of aroma, taste, pungency, heat and colour. This review aims to synthesise current knowledge on the principal spices used in Malaysian curry powder, their sensory and functional contributions, volatile flavour compounds, blending processes and quality requirements, thereby providing a scientific basis for formulation optimisation, consistent product quality and future industrial development. Common ingredients include coriander, cumin, fennel, chilli, turmeric, black or white pepper, cinnamon, star anise, cardamom, cloves, nutmeg, fenugreek and ginger, although their combinations vary according to culinary application and commercial formulation. The volatile compounds reported in Malaysian curry powder are consistent with the presence of several commonly used spices. For example, linalool is strongly associated with coriander, cuminaldehyde with cumin, *trans*-anethole with fennel or star anise, turmerones with turmeric and zingiberene with ginger. However, because several spices may contain the same volatile compounds, these associations should not be interpreted as definitive identification of their botanical sources. Processing operations, particularly cleaning, grinding and blending, influence flavour retention, homogeneity and product consistency. Commercial meat and fish curry powders also differ in their spice composition and sensory profiles, with meat curry powders generally exhibiting a stronger and more robust profile, while fish curry powders tend to be milder and more aromatic. Appropriate raw material selection, controlled processing, and compliance with chemical and microbiological quality requirements are therefore essential for producing consistent and acceptable curry powder. Further quantitative research on spice

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proportions, flavour interactions and functional properties is needed to support formulation optimisation and industrial quality control.

Keywords: Aroma, flavour, functional, quality, spice

INTRODUCTION

Spices are edible plant products used to flavour foods and beverages due to their appealing fragrances and sensory attributes. Spices are among the oldest traded commodities, dating back to at least two millennia. For thousands of years, aromatic plant materials have been used in food preparation (Farrell, 185). Definitions of spices may vary according to their geographical origin and historical use. According to Hirasa and Takemasa (1998), spices are sometimes defined by where they are grown or when they started to be used as spices. They are derived from dried plant parts, such as flowers, leaves, bark, stems, seeds, and roots (Figure 1). These parts are usually dried and ground to a mesh size of 40-60, corresponding to a particle size range of approximately 250-425 µm. The American Spice Trade Association (ASTA) (2023) defines the term spice as any aromatic vegetable substance in the whole, broken or ground form, except for those substances which have been traditionally regarded as foods, such as onions, garlic and celery. Today, the United States is both the world's largest consumer and the major importer of spices (Furth & Cox, 2004).



Figure 1. Representative spices commonly used in Malaysian curry-powder formulations in the form of whole and ground spices
Source: Adapted from Killebrew (2025)

With the trend of moving towards using spices to compensate for less salt and fat in food and the heightened popularity of ethnic foods in the West, the demand for spices in the world is increasing to record levels. According to Chironi et al. (2021), the globalisation of markets and the migration phenomenon have contributed to the modification of food preferences of consumers who gradually introduce spices into their eating habits. The delicate aroma of spices also contributes to consumer acceptance (Karadbhajne & Saraf, 2017). In Malaysia, the blends of spices are commonly used as important ingredients in food formulations in industry, apart from individual households and also the caterers, restaurants, etc. The growth of ethnic food popularity, including curries, also fuels the increasing demand for spices and their blends, providing a flavourful, distinctive aroma and tasty food products. Spices and herbs are also known as excellent sources of phenolic and polyphenolic compounds with bioactive functions and phytochemicals (Embuscado, 2019). According to Chhetri et al. (2015) and Hirasa and Takemasa (1998), spices are also being used in medicine, pharmaceuticals, perfumery, cosmetics and several other industries. Al-Habsi et al. (2025) reviewed the therapeutic properties, antioxidant and antimicrobial activities of herbs and spices. Studies relating to curry powder are mostly scientific and experimentally based, such as Meher and Meher (2020), who investigated chemical, rheological and sensory properties of curry-spices blend and Siripongvutikorn et al. (2024), who investigated phytochemical profiling and antioxidant activities of Thai curries. This review is devoted specifically to Malaysian curry powder, outlining the integrated spice matrix, particularly the relationships among spice composition, volatile flavour compounds, sensory functions, processing operations and quality requirements.

KEY SPICES AND THEIR FUNCTIONAL ROLE

Spices are unique and play multiple roles in food systems because they add both flavour and colour even in small quantities. According to the Spices Board (2021), Raghavan Uhl (2000) and Reineccius (1999), the key spices used in basic curry blends such as curry powder are coriander, fennel, cumin, chilli, turmeric, cinnamon, star anise, black and white pepper, clove and cardamom. Occasionally, ginger, nutmeg and fenugreek are used depending on region, ethnicity and cultural practices. Each spice has a distinctive aroma and flavour profile and performs a specific role in flavour development. Spices, when added to foods, also contribute to pungency as Raghavan (2010) noted, curry powder is considered a food that contributes ‘heat’. These spices are the fundamental aroma and taste ingredients of the product. The appropriate use of spices based on their functional roles is direct and specific in cooking or blending. Hirasa and Takemasa (1998) identified four functional categories of spices, i.e. flavouring, masking, pungency and colouring, as listed in Table 1.

Table 1
Basic functions of spices used in food

Functions	Spices
Flavouring	Allspice, cinnamon, fennel, cumin, basil, star anise, marjoram, cardamom, dill, nutmeg, parsley, mace, tarragon
Masking	Garlic, clove, onion, coriander, bay leaf, thyme, caraway, sage, oregano
Pungency	Pepper, black and white pepper, ginger, mustard, Japanese pepper
Colourant	Turmeric, paprika, saffron

Spices are used in ground, broken or whole forms to impart specific aroma, flavour and taste to foods. They can also be blended to form spice mix preparations after the pre-cleaning and grinding process. Malaysia has many spice blends such as curry powder, Chinese 5-spice powder, tandoori, 'biryani' mix, chilli blends, 'rendang', 'masala', 'Sichuan mala', 'bakuteh' and other localised blends (Raghavan Uhl, 2000). The most famous spice blend is the Malaysian curry powder. According to Ganie et al. (2022), foods without spices are often rejected and not preferred by consumers. Thus, adding spices to food improves its taste and flavour. When different spices are combined, their collective effect produces a richer and more complex profile. Numerous studies have focused on the culinary uses of spices, but limited attention has been given to their roles in Malaysian curry powder formulations and their associated functional properties.

Each spice has a unique aroma, taste and mouthfeel, giving different sensorial attributes derived from the volatile and semi-volatile phytochemicals that are generally produced as secondary metabolites in plants. Table 2 summarises the associated spices that give specific sensory attributes in terms of taste, aroma (smell), chemesthetic (spiciness, hot/

Table 2
Grouping of spices following sensory attributes of taste, aroma, chemesthetic and appearance by associated spices

Sensory Attribute	Sub-Category	Reineccius (1999)	Raghavan Uhl (2000)	Spices Inc (2026)
Taste	Sour	--	--	tamarind, caper, kokum, pomegranate
	Bitter	fenugreek, clove	fenugreek, mace, thyme, bay leaf, oregano, celery, ajowan	fenugreek, clove, mace, nutmeg, thyme, bay leaf, oregano
Aroma	Sweet aromatic	fennel, star anise, onion, cinnamon	cardamom, anise, star anise, fennel, allspice, cinnamon	cardamom, anise, fennel, cinnamon, allspice
	Fruity	--	--	fennel, coriander, star anise, tamarind

Table 2 (*continued*)

Sensory Attribute	Sub-Category	Reineccius (1999)	Raghavan Uhl (2000)	Spices Inc (2026)
Chemesthetic	Spiciness	cumin, cardamom, clove, coriander, ginger, white pepper	clove, cumin, coriander, ginger, Thai basil, canela	clove, cumin, coriander, ginger, bay leaf
	Heat/Hot	chilli, black pepper, ginger	chilli pepper, mustard, white pepper, black pepper, wasabi, fenugreek, mace, clove, thyme, bay leaf, oregano	black and white peppers, ginger, mustard, red pepper
	Pungent	black pepper, ginger, chili, garlic, cumin	mustard, horseradish, wasabi, ginger, garlic, onion	peppers, ginger, onion, mustard, red pepper, galangal
Appearance	Colour-contributing	--	annatto, paprika, turmeric, parsley, saffron	--

heat and pungency) and colour (appearance) following the description of main references from Reineccius (1999), Raghavan Uhl (2000) and Spices Inc. (2026). These compounds evolve as chemicals in plants and function to protect them against herbivorous insects and vertebrates, fungi, pathogens and parasites (Fraenkel, 1959; Walker, 1994). The grouping of spices following sensory attributes has an important contribution, especially to the manufacturing and further processing of the spices.

FLAVOUR

Flavour is considered one of the most important factors influencing food choice (Glanz et al., 1998). Aroma refers to the odour detected by the nose, whereas flavour is the overall perception formed by integrating aroma, the basic tastes and oral sensations (Al-Khalili et al., 2025; Lamkey, 2022). Dozens or even hundreds of compounds may contribute to this perception, together with textural and chemesthetic responses such as the warmth produced by pepper or the cooling sensation of menthol (Reineccius, 1999). Aroma is therefore a major sensory attribute affecting food identification, choice and acceptance (Bortnowska, 2010).

In curry powder, flavour is determined by the types and proportions of spices used in the blend. Although spices may also provide antioxidant and preservative functions, their primary contribution to curry powder is the development of its characteristic aroma, taste, pungency and heat. A typical blend may contain roasted and ground coriander, turmeric, cumin, fennel, star anise and cinnamon, with fenugreek, clove, mustard, black pepper, nutmeg or ginger (Raghavan Uhl, 2000). Variations in their selection and proportions

produce profiles ranging from mild and aromatic to warm, robust and spicy. Colour also affects the perception and acceptance of Malaysian curry powder by providing visual cues about its composition and expected flavour intensity (Clydesdale, 1993). Turmeric contributes a yellow hue, whereas chilli increases redness and provides heat. Their relative proportions, therefore, influence both product appearance and consumers' expectations of pungency and flavour.

The flavour of curry powder can be assessed using both sensory and instrumental methods. A trained sensory panel may evaluate the intensity of aroma, taste, pungency, heat, aftertaste and overall balance using a structured scale. Consumer acceptance may be measured using a nine-point hedonic scale for aroma, taste and overall liking (Lawless & Heymann, 2010; Lim, 2011), while descriptive sensory analysis can compare different formulations (Murray et al., 2001; Marques et al., 2022). Headspace solid-phase microextraction coupled with gas chromatography-mass spectrometry (HS-SPME/GC-MS) can complement these assessments by identifying characteristic volatile compounds.

BLENDING OF SPICES

Spice blending involves combining different ground spices in specific proportions to create unique flavour profiles and aromas (Desai, 2022). According to the U.S. Department of Agriculture (USDA) (2010), a spice blend is a combination of two or more individual spices that may also be mixed with other ingredients, such as salt, herbs, or extracts. The main purpose is to enhance the flavour of the final product. These blends are created by mixing different spices in specific proportions to achieve a specific flavour profile. It is about achieving a blend that enhances the aroma and flavour of foods, creating a new, more balanced flavour (Rosenblatt, 2024). Blending techniques also help to reduce the specific flavour of one spice (Hirasa & Takemasa, 1998). In many culinary preparations, it will be about personalisation. In Malaysia, curry powder has its own unique spice blends, resulting in a diverse culture and vibrant array of flavours. Raghavan Uhl (2000) stressed that food practitioners must also understand the spices and flavourings used in all their varieties, as spices are the fundamental building blocks of these blends.

The process of blending begins with two steps: pre-cleaning and grinding. Spices for blending must first be free from physical contaminants through a pre-cleaning process or pre-dusting step. The process removes impurities and dust or leaf contamination in the dried spices. The pre-dusting step is important to keep food quality and prevent misuse of food additives and adulteration (Momin & Jamir, 2021). Mature, dried spices are often contaminated with dust, dirt, leaves and insects (ASTA, 2023). Pre-cleaning also ensures a more consistent, better quality and safer product for consumers. Subsequently, whole dried spices are ground to a particle size of 60-80 mesh before blending. Grinding is generally conducted at ambient temperature. The frictional heat generated during conventional

grinding can increase product temperature and promote loss of heat-sensitive compounds, thereby reducing aroma quality. Low-temperature or cryogenic grinding can improve volatile components and aroma retention and help preserve the overall quality of ground spices (Ghodki & Goswami, 2016; Sharma et al., 2016; Kharra et al., 2025). A good grinding method is a technique for better flavour retention and homogenisation during blending (Krejčová et al., 2008). According to Aradwad et al. (2021), grinding plays an important role and needs special attention, especially regarding the loss of flavour during grinding. The heat generated during the process may cause the loss of volatile compounds, thereby reducing the overall flavour and aroma of the curry blend.

MALAYSIAN CURRY POWDER

Curry powder is the most well-known spice blend (Hirasa & Takemasa,1998). According to Raghavan Uhl (2000), curry blends vary by country or culture of origin and by the applications in which they are used. Countries like Malaysia, Thailand, Indonesia, India and Sri Lanka have the most varied, intense and complex blends in the world. Regardless of variations, it is expected for any curry powder to have a uniform colour, to be powdery and must not be lumpy as shown in Figure 2. While the ingredient lists differ in several ways, the final colour is quite similar, with a pleasant aroma and a slightly bitter taste (Raghavan Uhl, 2000; Tayyem et al., 2006).



Figure 2. Blended curry powder illustrating flow behaviour

Raghavan Uhl (2000) noted that curry blends from Southeast Asia, including Malaysia, have the most aromatic, hot and pungent flavours. The Malaysian curry powder is a popular spice mix blend of Indian origin. It is widely accepted across Malaysia's major ethnic and

cultural communities. It is also famous worldwide for its great taste, exotic flavours, colours, and aromatic spices. Most recipes and producers of curry powder or blends usually include coriander, turmeric, cumin and fenugreek in their blends. Kevin (2022) described that the Malaysian curry powder is unique, such that it combines the cooking styles and flavours of the Malay, Chinese and Indian culinary traditions, unlike common curry powders, which are specifically labelled for meat or for fish, and each blend features different seasonings. The fusion of the different cooking styles and dishes of three major ethnic communities, mainly Malay, Chinese and Indian, was also adopted in the formulation of fermented curry paste in Malaysia (Abolhassani et al., 2009). The flavour of the curry powder is typically warm, spicy, fragrant and slightly sweet with a balance of aroma, heat and pungency (Raghavan Uhl, 2000). Depending on the recipe, additional ingredients such as coriander, cumin, fennel, cinnamon, clove, mustard, cardamom, nutmeg, white pepper and ginger can be added in the blending process. Malaysian consumers chose coriander, fennel, cumin, star anise, turmeric, clove, ginger and black pepper as their important spice ingredients. This is shown by the presence of linalool, trans-anethole, cuminaldehyde, pinene, curcumene, turmerone, zingiberene and limonene volatile components in chromatogram analysis listed in Table 3, showing the relationship between the volatile components associated with the major spices. While some volatile components, such as pinene, are associated with a few types of spices, including coriander, cumin, fennel and black pepper, there are also single spices, such as turmeric, that produces more than one volatile component, i.e. turmerone and curcumene. According to Hirasa and Takemasa (1998), the major characteristics of the spices used are derived from terpene compounds, i.e., monoterpenes (C_{10}) and sesquiterpenes (C_{15}). The monoterpenes generally have a strong aroma and are very volatile. Choi (2013) identified that curry powder contains forty-eight compounds, comprising 36 terpenes,

Table 3
Associations between major spices used in Malaysian curry powder, their characteristic volatile compounds and reported flavour attributes

Main Compounds	Classification	Spice	Flavour Character
Linalool	Monoterpene	coriander	spicy[1,2]
Cuminaldehyde	monoterpenoid aldehyde	cumin	pungent[1], spicy[1,2]
Estragole	Phenylpropanoid	cumin, star anise	spicy[1], bitterness[3]
Turmerone	Sesquiterpene	turmeric	pungent[3]
Trans-anethole	Phenylpropanoid	fennel, star anise	aroma[1,2], sweetness[2]
β-caryophyllene	Sesquiterpene	black pepper, clove	spicy[1]
Geranyl acetate	Monoterpene	coriander	aroma[1,2]
Zingiberene	Sesquiterpene	ginger	spicy[1,2], pungent[1,2]
Limonene	Monoterpene	fennel, black pepper	aroma[4]

Source: [1]Reineccius (1999), [2]Spices Inc. (2026), [3]Raghavan Uhl (2000), and [4]Ajayi et al. (2019)



Figure 3. The colour and design of popular Malaysian curry powders from major brands, Babas, Allagappa and Adabi, for cooking meat or fish

5 alcohols, 4 benzenes, 2 carbonyl compounds and 1 ester. Kim et al. (1989) stressed that the characteristic aroma is associated with nutmeg, cumin, cardamom, turmeric, coriander, clove, allspice, cassia, fennel, celery seed and black pepper. The redness comes from the chilli powder used in the formulation. It is not shown because it is non-volatile. It should be noted that although chilli is a major ingredient in curry powder blending, it does not appear in the chromatogram due to its non-volatile nature. The aromatic, spicy flavour comes from the essential volatile oils and other volatile components (Lamkey, 2022) of the various spices used in the blending process. Each spice contributes to the complexity of the flavour.

Malaysia generally has two main types of curry powders (Figure 3), meat and fish. These are commonly used in meat or fish curries. The top three most popular brands in Malaysia are Babas, Adabi, and Allagappa. The Malaysian curry powder design in the packaging shows the company's identity, using respective meat to show the intended use of curry. The photo for meat type is generally redder. These distinct blends of spices are designed to enhance the flavour of their respective dishes in Malaysia. The fish curry powder is often used for seafood dishes, while the meat curry powder is used for meats like chicken, beef and mutton. The difference lies in the specific spice blend. Typically, the meat curry powder is stronger, more robust, redder and spicier than the fish curry powder. The fish type is milder, more aromatic and a little more yellowish in colour. According to

the ingredient lists presented in Table 4, the common spices for meat types are coriander, cumin, fennel, chilli, turmeric, white pepper, cinnamon, cardamom and star anise, whereas the spices of the fish types are similar but fewer, with the presence of black pepper, fenugreek and ginger giving a different flavour profile affecting the taste. The fish type is more yellowish. The meat curry powder is more robust and spicier to suit the stronger flavour of red meat, whereas the fish curry powder is milder and more aromatic to suit the flavours of fish. The tangy taste of prepared fish curry is generally introduced during cooking through acidic ingredients such as tamarind, *asam gelugur*, tomato or lime. Table 4 shows that meat curry powders may possess a more complex aromatic profile from the ingredient lists, presenting the presence of cinnamon, cardamom, star anise and nutmeg spices. Black pepper generally contributes a more pronounced aroma and pungent flavour than white pepper, together with the characteristic of heat, primarily associated with piperine. Its distinctive sensory properties have helped maintain its position as one of the most widely used spices worldwide (Freedman, 2020; Spence, 2024; van Ruth et al., 2019).

Table 4
Contents listed on the label of meat and fish curry powder from two popular brands of Babas and Allagappa

List of Ingredients	Babas		Allagappa	
	Meat	Fish	Meat	Fish
Coriander	✓	✓	✓	✓
Cumin	✓	✓	✓	✓
Fennel	✓	✓	✓	✓
Chilli	✓	✓	✓	✓
Turmeric	✓	✓	✓	✓
White Pepper	✓	✓	✓	--
Cinnamon	✓	--	✓	--
Cardamom	✓	--	✓	--
Star Anise	✓	--	✓	--
Bay Leaf	✓	--	--	--
Clove	✓	--	--	--
Nutmeg	✓	--	--	--
Methi Seeds	✓	--	--	✓
Black Pepper	✓	✓	--	--
Fenugreek	--	✓	--	--
Ginger	--	✓	--	--
Rice Flour	✓	✓	--	--

Table 5
Chemical requirements of Malaysian curry powder

Parameter	Limit	Requirement
Moisture (%)	Maximum	9
Volatile oil (mL/100 g)	Minimum	0.3
Non-volatile ether extract (%)	Minimum	7.5
Acid insoluble ash (%)	Maximum	1
Crude fibre (%)	Maximum	18

Source: Adapted from Malaysian Food Regulations (1985)

QUALITY OF MALAYSIAN CURRY POWDER

The quality objective for Malaysian curry powder is to produce a safe, consistent and high-quality blend that meets specified sensory, chemical and microbiological requirements. Standard operating procedures should therefore include specifications for raw materials, control of grinding and blending processes, assessment of finished-product consistency and the use of suitable packaging that provides protection against light, oxygen and moisture. As spices are natural agricultural materials, variations in properties such as flavour, colour and volatile oil content should be managed through careful raw-material selection, formulation adjustment and process standardisation. Quality evaluation should begin with the individual spices and may include measurements of moisture content, total ash, acid-insoluble ash, volatile oil, non-volatile ether extract, crude fibre and extraneous matter. In Malaysia, curry powder must comply with the Malaysian Food Regulations 1985, as summarised in Table 5. It commonly consists of a blend of 10-15 spices ground to a particle size of 60-80 mesh (Raghavan Uhl, 2000). The Malaysian Food Regulations 1985 specify that curry powder may contain other permitted food ingredients but must comprise at least 85% spices and contain not less than 0.3 mL of volatile oil per 100 g. Quality, however, can extend beyond compliance with compositional standards. Shiba et al. (1993) described four progressive concepts of quality which is first, fitness to standard which is assurance in conformity with established specifications, second, fitness to use which assurance that the product satisfies consumers' practical and sensory requirements, third, fitness of cost, which is provision of the required quality at an acceptable cost and fourth, fitness to latent requirements which is anticipation of needs that consumers may not yet have explicitly expressed. For the Malaysian curry powder, these concepts indicate that quality involves not only regulatory compliance but also consistent flavour, suitability for its intended culinary application, affordability and responsiveness to changing consumer preferences.

CONCLUSION

Malaysian curry powder is a complex spice matrix in which the selection, proportion and processing of spices determine its characteristic aroma, taste, pungency, heat and colour.

Variations between meat and fish curry powders reflect formulations tailored to different culinary applications. Raw material quality, controlled grinding and blending, protective packaging, and regulatory compliance are essential for maintaining flavour and product consistency. However, current knowledge remains largely descriptive because quantitative information on spice proportions and flavour interactions is limited. Future studies integrating sensory evaluation, consumer testing and instrumental flavour analysis could support formulation optimisation, quality standardisation and the development of Malaysian curry powders with consistent sensory and functional properties. The limitation of this review is that it identifies the spices of the two most popular and recognised commercial brands of curry powder in Malaysia as representatives of the study and does not provide detailed quantitative proportions of each spice, which is proprietary to the manufacturers.

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