

Article Info

Received: 07 Jan 2021 | Revised Submission: 28 Apr 2021 | Accepted: 05 May 2021 | Available Online: 15 Jun 2021

Detection of Adulteration in Spices

Pooja Pantola* and Pooja Agarwal**

ABSTRACT

Spices are dried part of a plant other than leaves commonly used for colouring or flavouring of food. Despite the fact, spices are also used as preservatives and has its medicinal importance too. Spices are grown all over the world. In production of spices India plays a major role. India is the world's largest producer, consumer and exporter of spices. 75 out of 109 varieties of spices are produced in India. In middle ages, spices were considered as precious as gold because of its medicinal and preservative properties. Nowadays, spice adulteration has become a serious problem which is increasing the impurity of products thus making it imperfect to consume. Adulteration is regularly done because of consumer's behaviour as they want to buy stuffs at lowest possible price. Ground spices usually adulterated with artificial colours, starch, chalk powder, etc. These additives increase their weight and also enhances appearance. Adulteration is not only degenerating the quality of food but also affecting the health of individuals. This study summarizes -Detection of food adulterant in red chilli powder and turmeric powder through various Physical and Chemical methods. Both branded and non- branded samples of above-mentioned spices were collected to study the level of adulteration and quality difference between them. Detection was carried out through chemical analysis and visual inspection. This study is done to aware public about food adulteration.

Keywords: Adulteration; Adulterants; Chemical methods; Food.

1.0 Introduction

Spice refers to any dried part of plant which includes seed, fruit, root, bark, bud or vegetable substance other than leaves [1]. It is primarily used for flavouring, colouring and seasoning a recipe. It is also used as food preservative [2] and some of the spices has its medicinal importance too. India produces over 7 million tonnes of different spices per year [2]. India is called as "the spice bowl" of the world [3]. Spices are always in demand because of their good taste and flavour. They are most commonly found in ground or powdered form which make them a top target for adulteration. Adulteration of spices can be defined as loss of natural composition and quality of spices due to addition or subtraction of foreign substance to and from the spices. The substance which are used to lower the quality of spices are called as adulterants. They make

spices unhygienic and contaminated which affects the health of individual and causes various harmful diseases like stomach disorder, lead poisoning, cancer etc. In Most cases used and rotted spices are mixed with fresh ones to increase the quantity of spices thus in case to enhance profit [4]. Studies reported that packaged spices are less adulterated as compared to unpackaged spices which carries a lot of adulterants. Commonly used adulterants in spices are sand, dirt, artificial colour, chalk powder, papaya seed, horse dung, lead chromate, etc.

This study analyse the type of adulterant found in two commonly used spices - Red Chilli and Turmeric by using several physical and chemical analysis. Red Chilli is a fruit which belongs to Genus Capsicum. Red Chilli is known for its fiery and spicy nature. It consist of huge amount of capsaicin which give warmth to dishes and also help in losing weight and boosting metabolism [5]. Capsaicin binds with

*Corresponding author; Department of Biotechnology, Galgotias University, Yamuna Expressway, Greater Noida, Uttar Pradesh, India (E-mail: poojaocm5@gmail.com)

**Department of Biotechnology, Galgotias University, Yamuna Expressway, Greater Noida, Uttar Pradesh, India (E-mail: pooja.agarwal@galgotiasuniversity.edu.in)

pain receptor, which are nerve ending that sense pain. It causes burning sensation but does not cause any real burning injuries. Red chilli is incorporated with great rich content like vitamin C, vitamin A, vitamin B6, vitamin K1, potassium and copper. It is also known to reduce inflammation and act as natural pain reliever. The food colouring ability of red chilli is due to presence of mixture of carotenes and xanthophylls in it [6]. Chilli Powder act as base material for making spicy, hot and flavoured food. Two main types of chilli powder which are widely used in Indian cuisine- red chilli powder and Kashmiri chilli powder. Red chilli powder is generally prepared from cayenne chilli peppers or it can also be made from local chilli varieties such as byadagi chillies and Guntur chillies. Kashmiri chilli powder is prepared from less pungent Kashmiri chilli varieties. It imparts vibrant red colour to dishes. Red chilli powder can be stored for 10-12 months at cool and dry places. It should not be placed under direct sunlight and heat as it induces microbial growth and causes contamination by pathogenic microorganisms. Chilli powder must be kept free from living or dead insect, mild growth, insect fragments and rodent contamination as it reduces its quality. Natural way of keeping chilli powder fresh for long time is by adding a chunk of asafoetida in it.

Turmeric commonly called as haldi is a flowering plant whose fresh roots and dried, ground turmeric powder is used in cooking. Turmeric is also known as “Indian Saffron” [7]. In cooking both fresh turmeric root and dried, ground turmeric powder is used. Curcumin imparts characteristic yellow colour in Turmeric. Curcumin is insoluble in water and ether but it disperses in ethanol and other organic solvents.

Turmeric has a musky, earthy aroma and pungent, bitter, peppery taste. Turmeric contains essential oils such as turmerone, zingiberene, cineole and p-cymene. Turmeric is well known preservative. It is effective against gastro-intestinal diseases, inflammation, wounds, rheumatism, coryza, cough etc. It has anti-biotic, anti-oxidant, anti-arthritic, anti-amyloid, anti-ischemic, anti-microbial, anti-inflammatory [8], anti-ageing and carminative properties too. It has potential against various cancer, diabetes, allergies, arthritis, Alzheimer's disease and other chronic diseases. There is no presence of cholesterol in turmeric and it is rich in antioxidants and dietary fibre which help to reduce blood LDL or

bad cholesterol levels. Various essential vitamins are also present in turmeric powder such as pyridoxine, choline, niacin and riboflavin. It also contains various minerals such as calcium, iron, potassium, manganese, copper, zinc and magnesium. Turmeric loses its potency if exposed to light or heat so it must be stored in air tight containers in cool or dark places.

In food products use of artificial additives is increasing day by day, thus spices are adulterated to fulfil the increasing demand. Red chilli and turmeric powder are commonly adulterated spices in market as it is used by mass population. Brick dust is added to chilli powder to increase its quantity, on the other hand metanil yellow and lead chromate is added in turmeric powder which causes adverse effect to health of individual [9]. Various disorders are caused due to adulteration of spices. Given below is the list of some common adulterant in red chilli powder and turmeric powder and disease caused by them [Table 1].

Table 1: List of Adulterants Present in Red Chilli and Turmeric and Disorder Caused by them [10-16].

Spices	Adulterants	Disease/ Disorder
1. Chilli Powder	Yellow and Sudan red colour	Cancer
	Brick Dust	Respiratory Problems
	Lead soluble salts	Lead poisoning, metal toxicity
	Oil soluble tar	Heart Disease, damage to liver, tumor.
2. Turmeric Powder	Metanil yellow	Cancer, Stomach disorder
	Lead Chromate	Cancer, Anemia, Neurotoxicity, Reduce male fertility, etc.
	Chalk	Indigestion
	Tapioca Starch	Stomach Disorders
	Aniline Dyes	Carcinogenic

2.0 Methodology

This experimental study was carried out on spices of Delhi NCR at DS Spiceco Pvt. Ltd. Noida, Uttar Pradesh. This study is done for determination of various adulterants present in red chilli and turmeric powder by using physical and chemical methods.

2.1 Physical analysis

100-200 gram of sample was taken in a petri dish and analysis was done using methods like visual inspection, manual handling and sensory evaluation on the basis of various parameters which includes colour, mold contamination, living or dead insects, rodent contamination, extraneous matter, odour/taste etc.

2.2 Chemical analysis

3 Different brands of red chilli and turmeric powder (SD1 and SD2) along with 3 samples (LM1, LM2, LM3) from local grocery shop i.e., from Chandni Chowk and Kamla Nagar market of Delhi were collected and analysed by various chemical tests.

2.2.1 Red chilli powder

1. Presence of saw dust and brick powder: one teaspoon of chilli powder was added in a beaker containing water. Pure chilli powder floats while adulterated will settle down.
2. Presence of artificial colour: A teaspoon of red chilli powder was added to a glass of water, change in colour of water indicates the presence of artificial colour in it.
3. Presence of Starch: Few drops of iodine was added to chilli powder taken in a test tube. Appearance of bluish colour indicates presence of starch.
4. Presence of Sudan Red: A sample of chilli powder was taken in a test tube. Dilute nitric acid is added to it. It is then filtered and in the filtrate 2 drops of potassium iodide is added. As a result of which yellow colour precipitate was formed which indicates the presence of Sudan red.
5. Presence of Rodamine B: 5 ml. of Acetone was added to chilli powder taken in a test tube. Immediate red colour appearance indicates the presence of Rodamine B.
6. Presence of oil soluble coal tar: 5 ml of ether solvent was added to a test tube containing chilli powder and is shaken well. 2ml of dilute hydrochloric acid was taken in another test tube and ether layer is transferred to it. Appearance of pink/red colour of lower acid layer indicates the presence of oil soluble coal tar.

2.2.2 Turmeric powder

1. Presence of yellow lead salts: In a test tube 2gm of turmeric powder was taken and concentrated hydrochloric acid was added to it. Magenta colour indicates the presence of yellow lead salts.
2. Presence of chalk: 2gm of sample was taken in a test tube to which 5ml of water and few drops of concentrated hydrochloric acid was added. Effervescence came out which indicates the presence of chalk in it.
3. Presence of Aniline Dye: A sample of turmeric powder was taken in a test tube. In few drops of water and 5 ml of spirit was added. As a result, yellow colour disappeared which indicates the presence of aniline dye in the sample.
4. Presence of Metanil yellow: A sample of turmeric powder was taken in a test tube and 13N sulphuric acid was added to it. On adding distilled water red colour disappeared which indicates the presence of Metanil yellow in the sample.
5. Presence of starch of maize, wheat and rice: It is observed by using microscope. In microscopic view pure turmeric appears to be yellow in colour and bigger in size.

3.0 Chromatographic Analysis

Qualitative estimation of samples of Red Chilli and Turmeric powder by means of Thin Layer Chromatography (TLC) was done to detect the presence of Sudan Red I Dye.

3.1 Extraction of sample

0.5gm of different samples of red chilli and turmeric powder were dissolved in 10ml of chloroform and placed in rotatory shaker for about 16-18 hrs. They were then removed and filtered. Filtrate obtained is further used for chromatography.

3.2 Preparation of standard solution

Stock solution of Sudan Red I was prepared by dissolving 1mg/10 ml of solvent in it. Solvent used here was chloroform. The working standard solution was obtained from the stock solution by dilution (1:10) with solvent at the time of analysis.

3.3 Experimental work

After this, spots of samples and standards are applied on TLC plate (15cm×7cm) by using capillary. It was then placed in TLC jar containing solvent system (mobile phase) of N-hexane and ethyl acetate in the ratio (18:2) for an hour. After this, retardation factor (R_f) is calculated by using the formula - distance travelled by solute/distance travelled by solvent. Retardation factor (R_f) values of various samples showing presence and absence of Sudan Red I dye in Red chilli and Turmeric powder are given Table 2 and Table 3.

Table 2: Chromatographic Analysis of Red Chilli Samples

Sample	Distance travelled by solvent (cm)	Mean distance travelled by spots (cm)	Rf Value	Absence or presence of Sudan Red I dye
SD1	5.3	-	-	Absent
SD2	5.3	-	-	Absent
LM1	5.3	4.3	0.81	Present
LM2	5.3	4.5	0.84	Present
LM3	5.3	4.6	0.86	Present

Table 3: Chromatographic Analysis of Turmeric Powder Samples

Sample	Distance travelled by solvent (cm)	Mean distance travelled by spots (cm)	Rf Values	Absence or presence of Sudan Red I dye
SD1	5.5	-	-	Absent
SD2	5.5	-	-	Absent
LM1	5.5	4.4	0.8	Present
LM2	5.5	4.6	0.83	Present
LM3	5.5	4.5	0.81	Present

Table 4: Observations Made during Analysis of Chilli Powder

Adulterants	Samples SD1 LM2	SD2 LM3	LM1
Brick powder	Absent	Absent	Present
Artificial colour	Absent	Absent	Present
Starch	Absent	Absent	Absent
Sudan red	Absent	Absent	Present
Rodamine B	Absent	Absent	Present
Oil soluble coal tar	Absent	Absent	Present

Table 5: Observations Made during Analysis of Turmeric Powder

Adulterants	Samples SD1	SD2	LM1	LM2	LM3
Yellow lead salts	Absent	Absent	Present	Present	Present
Chalk	Absent	Absent	Present	Absent	Present
Aniline Dye	Absent	Absent	Present	Present	Absent
Metanil yellow	Absent	Absent	Present	Present	Absent
Starch of maize, wheat and rice	Absent	Absent	Present	Absent	Present

4.0 Results and Discussions

Each sample was analysed by using different methods to obtain accurate results. The observation drawn from analysing the samples is given Table 4 and Table 5. The study was carried out to determine the presence of adulterants in red chilli and turmeric powder. With increase in population the demand is more than the supply in market. To fulfil the population needs and to increase profit margins, spices are adulterated in large scale. This adulteration not only reduces the quality of spices but also has great impact on health of the individual without their knowledge. It is clear from the above results that spices are adulterated by using chalk powder, starch, Rodamine B, Aniline dye, metanil yellow, lead salts etc. Among all metanil yellow and lead salts are most harmful adulterants which causes cancer. Starch is the most abundant adulterant found in red chilli and turmeric. Adulteration not only degrades the quality of spices but also affects human health. Regular consumption of adulterated spices leads to problems like nausea, anaemia, paralysis, insomnia, abortions, brain damage, vomiting, Constipation and even mental retardation. Dyes which are added in spices to enhance its colour are continuously harming the health of the individual. This whole study was done to understand how safe the spices that are consuming nowadays are.

4.0 Conclusions

Without the addition of spices Indian food is incomplete. From above results and discussion, we can summarize that presence of adulterants in spices are causing severe health related problems which we

are unaware of. One should buy packed spices from the trusted sources containing either by ISI mark or an Agmark. While purchasing spices we must visually examine the spices that we are buying to ensure the absence of insects and other foreign material in it. Also, government should initiate proper quality check of spices and take necessary action against those who are selling adulterated products to increase their profit.

5.0 Acknowledgement

The authors gratefully acknowledge DS Spiceco Pvt. Ltd. for providing necessary facilities to carry out this work.

References

- [1] J Shweta, SY Digvijay, MK Mishra, AK Gupta. Detection of adulterants in spices through chemical methods and thin layer chromatography for forensic consideration, 6 (8), 2016, 8824-8827.
- [2] S Bharathi, A Sukhita, J Moses, C Anandharamakrishnan. (2018). Instrument-based detection methods for adulteration in spice and spice products – A review. *Journal of Spices and Aromatic Crops*, 27 (2), 2018, 106-118. DOI: 10.25081/josac.2018.v27.i2.1099.
- [3] K Pradhan. Exploration and Extrapolation of Extension Strategy for Promotion of Spice Production and Processing In India. *Indian Spices*, 2018, 421-438. https://doi.org/10.1007/978-3-319-75016-3_16
- [4] J Chandila, D Puri. A Comparative Study on Consumer Perception towards Packaged Spices among Rural and Urban Women. *International Journal of Health Sciences & Research*, 9 (8), 2019, 399-405.
- [5] S Sanati, B Razavi, H Hosseinzadeh. A review of the effects of *Capsicum annuum* L. and its constituent, capsaicin, in metabolic syndrome. *Iranian Journal of Basic Medical Sciences*, 21(5), 2018, 439-448. DOI: 10.22038/ijbms.2018.25200.6238
- [6] M Mishra. Detection of adulterants in spices through chemical methods and thin layer chromatography for forensic consideration. *International Journal of Development Research*, 6, 2016 8824-8827.
- [7] P Gupta, J Ahmed, U Shivhare, G Raghavan. Drying characteristics of red chilli. *Drying Technology*, 20 (10), 2002, 1975-1987.
- [8] I Kalkan. Curcumin: The Miraculous Golden Ingredient of Indian Saffron. *New Trends and Issues Proceedings on Advances in Pure and Applied Sciences*, 7(7), 2015. <https://doi.org/10.18844/gjpaas.v0i7.3160>
- [9] C Nwankwo. Nutritional Composition of Turmeric (*Curcuma longa*) and its Antimicrobial Properties. *International Journal of Scientific and Engineering Research*. 5, 2014, 1085 – 1089.
- [10] A Choudhary, N Gupta, F Hameed, S Choton. An Overview of Food Adulteration: Concept, Sources, Impact, Challenges and Detection. *International Journal of Chemical Studies*, 8 (1), 2020, 2564-2573.
- [11] S Sen, P Mohanty, V Suneetha. Detection of Food Adulterants in Chilli, Turmeric and Coriander Powders by Physical and Chemical Methods. *Research Journal of Pharmacy and Technology*, 10 (9), 2017, 3057-3060. <http://dx.doi.org/10.5958/0974-360X.2017.00542.X>
- [12] *Encyclopedia of Food Safety*, 3, 2014 3, 413-416
- [13] PM Kaur, SK Shukla. Detection of Non-Permitted Food Colors In Edibles. *Journal of Forensic Research*, 4, 2015 <https://doi.org/10.4172/2157-7145.1000S4-003>
- [14] S Sharma, N Goel, P Paliwal. Evaluation of Adulterants in Food by Different Physico-Chemical Method. *International Journal for Scientific Research and Development*, 4(11), 2017, 613-2321.

- [15] V Cornet, Y Govaert, G Moens, G., LJ Van, JM Degroodt. Development of a fast analytical method for the determination of Sudan dyes in chilli and curry containing foodstuffs by high-performance liquid chromatography-photodiode array detection. *Journal of Agricultural and Food Chemistry*, 54, 2006, 639-644.
- [16] X Yu, J Lee, H Liu, H Yang. Synthesis Of Magnetic Nanoparticles To Detect Sudan Dye Adulteration In Chilli Powders. *Food Chemistry*, 299, 2019, <https://doi.org/10.1016/j.foodchem.2019.125144>.