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IDENTIFICATION OF ADULTERATION IN HOUSEHOLD CHILLI POWDER FROM ITS IMAGES USING LOGISTIC REGRESSION TECHNIQUE

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Abstract

Adulteration is proof of food quality deterioration with either adventitious or deliberate methods through the production of synthetic mixtures, by-products etc. Within a nation such as India, where the population is enormous, and where the buyer is not noticed, the display of corruption is hardly shocking. Everyday use, such as fruit, spices and milk, is seen as much as our dismissal defiled. Some manual procedures occur in everyday foodstuffs to detect adulteration. Yet human mistakes can make it unreliable. To make this process automatic, we are introducing a novel method to identify adulteration in Kashmiri chilli powder by its images. Here, we are considering adulteration as brick powder mixed chilli powder. We have used 100 pure red chilli powder images and 50 red chilli powder which has been mixed with bricks powder. To classify images, we have used logistic regression and got 82% accuracy in process implementation.

Keywords: chilli powder; adulteration; logistic regression; household spices

I. Introduction

Food is a basic existence necessity. We eat food for various aerobic activities and improve our vitality. Each being requires nutrition to grow, function and sustain forms of life. Different types of foods are available on the market today and we rely on different food sources on a regular basis, including fruits, natural products, kernels, milk products and so on. The lure of money and the general triviality for humanity led adulterants to add food to the more harmful brick powder and boric powder from the tiny pillars of rice.

Food adulteration indicates that poor quality, mediocre, unsatisfactory, useless items are found in food or mixed with them. Adulterated food is harmful because it can be toxic and can impair the well-being of individuals and may refuse essential nutrients for the legitimate development and enhancement. The most popular adulterants that have been identified include some synthetic materials for quicker maturation of organic goods, blending with the largest of decayed goods of the earth, like some ordinary and [1] compound shoppers' colors, blending soil, rocks, stones, sand and marble, grain, beats and different outputs, and cheaper and less mediocre materials.

The adulterant tests were performed in popular and well-known sources like FSSAI, ISI, AGMARK, BIS and others. During the study, the adulterant items were contained in packaged and unbranded foods. The Indian Food Safety and Standards Authority (fssai) is proposing the formulation of regulations on food safety as well as guidelines on food and toxin and residue, and regulations on food safety, 2011 [2]. FSSAI has also crucified buyers in terms of food deterioration and provided tools like the DART Book to assist them in the domestic identification of food pollution.

Some popular grooming foods include wheat flour, cooked rice, refined fleece meal, bajra, honey, turmeric, red powdered chili, milk, sugar, coffee powder and a lot of other foods [3]. The adulterant is detectable across multiple methods, including manual processes and chemical processes. The key focus in this paper is to detect adulteration by image processing techniques in the Kashmiri chilli powder.

Chilli powder [4]is a dried, crushed fruit of one or more chili type, along with other spices. Chili powder. This is used in cooking dishes as a spice and as a seasoning. Chilli powder is reduced to brick powder, plum solvent salts, Rhodamin B and oil, which can lead to a number of diseases including, for example, stomach, metal hazards, cancer, food poisoning, cardiovascular disease, heart attacks, liver damage, the tumor and many others.

Adulteration in red chili powder is characterized by manual processes. Take 1 tsp [5] of the powder of the chili and pour it into a bowl. This indicated the proximity of brick powders or sand at the point where the build-up was tested and any lumpiness was felt.

We have proposed a new approach for identifying adulterated Kashmiri chilly powder from the digital camera image. We measure color features and logistic regression is performed for training and classification. The following paper is organized. The related work in this area is defined in Section II. The terminologies used in this paper are discussed in Section III. The proposed method and result are defined in Section IV-V. Section VI ultimately presents conclusion.

II. Related Work

The research on chili powder adulterated by means of Sudan I dye was carried out by Haughey, S.A., et al. [6]. With near infrared reflectance spectroscopy and Raman spectroscopy, spectral images were made. Spectral data have been subject to quantitative and qualitative calibration models and statistics. A statistical algorithm was used to calculate quantitative model coefficients, based on the spectral data (NIRS / Raman), and pre-treatment of the data was defined to be 0.891-0.994.

Innovative high resolution mass spectrometry, with a coefficient of variance less than 20 percent was introduced. Simona et al. have proposed a [7] simple screening technique to classify Sudan dyes in adult tomato sauce, chilli powder and palm oil. The technique includes a small preparation for the sample, complete avoidance of fluid chromatography and then identification and identifying by ambient pressure chemical ionization in positive flight ionization mode.

G. Rajakumar et al. have implemented [8] the VLSI Electronic Image Processing Detection based adulteration in food samples. Selected and calculated images are various types of food samples. Such images are compare with regular images stored within the Field Programmable Gate Array (FPGA) with the algorithm of the Distance Matrix in the Very Large Scale Integration (VLSI) implementation.

A. Justin Diraviam et al. have developed a novel method for the identification of food adulteration with a [9] digital camera in selected food products. Chilli powder, black pepper and

milk are the foods chosen. Image feathers consisting of average, standard difference, entropy, smoothness and local tetra pattern are measured. Feature data are compared and created based on both the data set food pictures and the input food pictures in the identification of foreign particles in food products.

III. Methodologies

To build a consistent vector, different color features are defined. For analysis of chilli powder pictures, we have used RGB color channel here.

Logistic regression, which is also called a logistics model, analyses the correlation between many separated [10] variables and a category variable and calculates an event 's likelihood by fitting the data to a logistical curve. Two logistic regression models, binary regression and multinomial logistic regression are available. Binary regression is usually used where the dependent variable is inconsistent and independent variables are categorical or continuous. When the dependent variable is not binary and contains more than two types, it is possible to use a multiple regression model.

This research mainly focuses on the detection of the Kashmiri red chilli powder which is mixed with bricks powder, whose color features as listed in the Table1 and Table 2. The other adulterants such as Sudan dye is not considered in this discussion. Here, we have used binary logistic regression as there are only two images classes for classification: pure and adulterated chilli powder, for that we have used label as 0 and 1.

IV. PROPOSED APPROACH

We are performing following steps to identify adulterated chilli powder from it digital images.

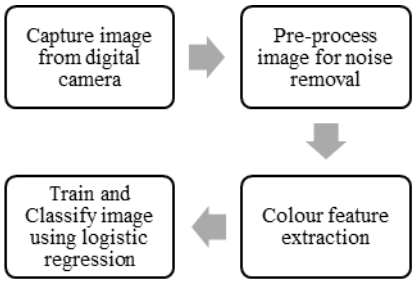

Figure 1: *Block Diagram of Proposed Model*

I. Capture image from digital camera and Pre-processing

Chilli powder images are taken using digital camera (See Fig. 2). Both branded and un-branded chilli powder are considered to create image dataset. To generated adulterated powder image, 15-gram brick powder adulterant added to 50-gram pure chilli powder sample is taken by camera. All the images are taken in such a way that bottom surface appears in white color (see Fig. 3).

II. Pre-process image for noise removal

To remove noise, Gaussian filter is applied so that image looks more smooth and sharp. To remove background, color masking operation is applied after Otsu's Thresholding techniques (See Fig. 4).

Figure 27: Red Chilli Powder

Figure 3: *Red chilli powder mixed with brick powder*

The objective of Otsu's thresholding [11] is to find the threshold value at which the sum of the first and context spreads is minimal.

Figure 4: *Masked image of red chilli powder*

The technique for selecting a specific background color is known as color masking to [12] eliminate false regions caused by color change. The color of the background is the color of the mask. Here, Red color channel is used to separate foreground with background. And black color is applied as mask.

III. Color Feature Extraction

Each channel's mean is measured and used as the image classification parameter. The RGB image consists of three images (one for each channel), in which each image can store discrete pixels between 0 and 255 with typical brightness intensities.

$$\text{Mean(R/G/B)} \quad = \sum_{k=0}^{n} \frac{Rc\ or\ Gc\ or\ Bc}{n} \tag{1}$$

Here, mean of each channel (C) which is Red, Green and Blue, calculated by separating each in matrix (see Table 1 and Table 2) and applying logic for dominant color formation so that it presumes actual values as human vision.

Table 1: *Mean of Red, Green and Blue Channel (Mixed Red Chilli Powder)*

	Mean of each RGB channel		
Label	R	G	B
Mixed Red Chili 1	81.34967	109.8886	171.901

Mixed Red Chili 2	0.134404	0.194583	0.387035
Mixed Red Chili 3	74.2278	107.012	179.7792
Mixed Red Chili 4	0.064241	0.105532	0.223678
Mixed Red Chili 5	0.038761	0.075368	0.381909
Mixed Red Chili 6	0.032687	0.058498	0.369771

Table 2: *Mean of Red, Green and Blue Channel (Original sample red chilli powder)*

Mean of each RGB channel			
Label	R	G	B
Sample Red Chili 1	81.34967	109.8886	171.901
Sample Red Chili 2	0.134404	0.194583	0.387035
Sample Red Chili 3	74.2278	107.012	179.7792
Sample Red Chili 4	0.064241	0.105532	0.223678
Sample Red Chili 5	0.038761	0.075368	0.381909
Sample Red Chili 6	0.032687	0.058498	0.369771

IV. Training and Classification of red chilli powder images

All the dataset images are trained by its color features. Dataset is divided into 80:20 ratios to generate training and testing data. For creating dependent variable vector, labels are specified as 0 for adulterated and 1 is for pure chilli powder. The model has been built for classification of red chilli powder using logistic regression. In the following, the formulas for logistic regression model are briefly listed for reference.

$$Y = b0 + b1 * X1 + \ldots bn + Xn \quad (2)$$

Here, Y is dependent variable that is label in chilli dataset and X1, and Xn are explanatory variables (colour mean features).

$$P(X) = 1 / (1 + e - (b0 + b1 * X1 + \ldots bn + Xn)) \quad (3)$$

In above equation, Sigmoid function is applied on linear regression, in order to calculate prediction value.

V. Result and Analysis

We have used python programming language for execution and simulation process. After creating and testing classification model, confusion matrix and ROC curve has been generated to analysis actual values and predicted values (see Table 3 and Fig. 5).

This confusion matrix is used to evaluate a model 's efficiency. The confusion [13] matrix is presented in a table with below four values belonging to two predicted and actual categories.

True Positive (TP): Predicted positive and the result is true. Model predicted that the chilli powder is pure, and it is pure in actual dataset also. Here, Model is predicting 85% correct true values for pure data.

True Negative (TN): Predicted negative and the result is true. Model predicted that the chilli powder is mixed, and it is mixed in actual dataset also. Here, Model is predicting 80% correct true values for mixed data.

Table 19: *Confusion Matrix*

		Predicted	
		Pure	Mixed
Actual	Pure	85%	15%
	Mixed	20%	80%

False Positive (FP): Predicted positive and the result is not true. Model predicted that the chilli powder is pure, and it is mixed in actual dataset. Here, Model is predicting 15% incorrect true values for pure data.

False Negative (FN): Predicted negative and the result is not true. Model predicted that the chilli powder is mixed, and it is pure in actual dataset. Here, Model is predicting 20% correct true values for mixed data.

Receiver Operating Characteristic curve (ROC) is a probability curve and AUC represents degree or measure of [14] separability.

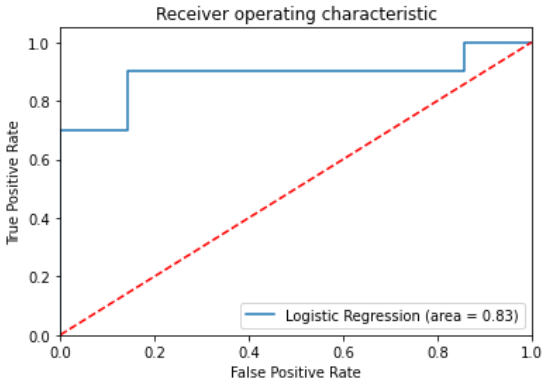

Figure 28 ROC curve for predicted model

It tells how much model is capable of distinguishing between classes. Fig. 5 shows that AUC approximately 0.83 which means the proposed model is 83% skilful of bifurcating between two class labels pure and mixed chilli powder.

We have calculated precision, recall and f1-score value to find accuracy of model. The precision [15] is a combination of the number of positive examples properly classified and the number of positive examples predicted. We got 0.83 precision value. Recall is measure of positive examples labelled as positive by classifier. We got 0.82 as recall value. F1 score is a weighted mean

of the recall and precision. We got 0.82 f1-score. This result shows that proposed model is working well to classify pure and mixed powder.

VI. Conclusion

Adulteration is major problem in food industry as it causes many diseases in humans. Red chilli powder is adulterated in many ways and one of the common way is to add bricks powder. Though, there are manual methods are available to identify outside material in chilli powder but automation process is also required for faster and accurate analysis. We have introduced an approach to identify adulterated chilli powder from its images. We have use color feature that s means of each RGB channel and classify the data using logistic regression. After analyzing true – false ratio of prediction data, model give 82% accuracy to predict data that whether image is of adulterated chilli powder or pure chilli powder.

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