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# Authentication of origin of meat species processed under various Indian culinary procedures using DNA barcoding

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<https://doi.org/10.1016/j.foodcont.2018.02.012> 

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## Highlights

- Study conducted for traceability compliance of Indian culinary processing of meat.
- Culinary processing do not alter DNA quality required for traceability compliance.
- All samples were successful in amplifying COI gene, no evidence of PCR inhibitor.
- Employed samples were successful in generating full length DNA barcodes.
- Species authentication under pickled products failed in all preparations.

## Abstract

Indian food is exceptional from rest of the world not only in taste but also in culinary procedures, which reflects a perfect blend of various cultures and ages. Indian culinary procedures involved in preparation of Indian meat recipes, incur heavy processing and profound use of spices. In parts, the authentication of processed ingredients present in the food is a major concern to ensure food safety and quality as well as for certification. There is a growing demand for the enhancement of quality controls, hence addressing scientific research towards the development of reliable molecular tools for food traceability. Over the past decade, DNA barcoding was most commonly used molecular method, which can ascertain biological specimens, and is used for the identification of both raw materials and processed food. We tested the applicability of this method to authenticate variously processed meat species under Indian culinary practices and revealed DNA barcoding can provide, fast and reliable method for its traceability. The obtained results indicated that Indian culinary practices for popular meat recipes although use considerable processing and profound spice, do not interfere meat DNA quality for downstream application for species authentication using DNA barcoding by COI gene. Species authenticity for geographical origin is exigent by the DNA barcoding procedure. However, the pickled products are not trackable for species authentication since the culinary processes involved, challenges DNA quality for further applications.

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## Introduction

Indian food is exceptional from rest of the world not only in taste but also in culinary procedures, which reflects a perfect blend of various cultures and ages. Generous use of spice is the speciality of almost all types of recipes. Strong impact was made on the Indian cuisine during the Mughals era in sixteenth century. Mughals' cooking was truly based on meat, whose influence is strongest in north and central India. Since then well-known Mughlai dishes have been developed into an important culinary art and became part of Indian cuisine. Several recipes are derived from original Mughal cooking blends and popularized throughout the world. These dishes are very popular globally through Indian restaurants or are sold as ready to eat processed food in super market like, frozen, canned or dehydrated food. In parts, the food prepared either in restaurants or processed in large batches in food industries, food authentication is an important area in recent past (FSAI, 2013, FSSAI, 2013).

The consumer awareness and concern about the food they consume is considerably elevated. Globally, consumers are empowered by the Court of Law to know about their food and its source. The traceability is important in food authentication, which ensures the origin of food. In human

civilization, some societies prefer certain type of food while other food items are strictly prohibited, either due to religious concern, health issues or personal preferences. Another issue associated is food frauds by substituting highly valued food components with low quality ingredients of similar origin (Bottero and Dalmaso, 2011, Khedkar et al., 2016). It not only defrauds the consumer but may result into psychological consequences. Any case of food adulteration especially when reported by the media, has a great impact on public opinion (Galimberti et al., 2013). For consumer and regulatory confidence with respect to food quality and food safety along the supply chain from production, processing and retailing from the point of origin to the point of sale is expected (Turci, SavoSardaro, Visioli, Maestri, & Marmiroli, 2010). Therefore, the description and/or labelling of food must be authentic and accurate, principally if the food has been processed removing the ability to distinguish one ingredient from another.

Some examples of substitution of high quality materials with ones of lower value given that superior produce can significantly appreciate the price difference compared with the corresponding replacing ingredient. It is easy to see the commercial gains that can be made by devious food producers (Ashurt and Dennis, 1996, Patel, 1994). They shall, if possible, give information on animal species, origin, authenticity, composition, age and production systems (Woolfe & Primrose, 2008). Consequently, it is necessary to have reliable methods, which allow fast and unequivocal information related to these issues. The demand for reliable food traceability systems has addressed the scientific research, hence generating different analytical approaches to this issue (Rasmussen and Morrissey, 2008, Bottero and Dalmaso, 2011, Fajardo et al., 2010, Mafra et al., 2008, Asensio et al., 2008).

In recent past detection of species using DNA barcoding has become more popular and reliable due to use of mitochondrial DNA and universal primers in contrast to the use of species-specific PCR methods for detection of various mammalian and poultry species in meat and meat products (El Sheikha et al., 2017, Zhong et al., 2017, Hellberg et al., 2017, Arslan et al., 2006, Meyer et al., 1994). These PCR methods targets genomic as well as mitochondrial DNA for the purpose of meat species identification, even in cooked meat under different processing conditions. However, in the present study the mitochondrial DNA was used for meat species identification because of the maternal inheritance, normally only one allele exists in an individual and thus no sequence ambiguities are expected from the presence of multiple allele (Unsel, Beyermann, Brandt, & Hiesel, 1995).

Moreover, due to specific cooking methods, spicy taste, delicacy and attractive food presentation, Indian meat recipes are in appreciation all over the world. In all these recipes, excessive use of oil, herbs, spices and high processing temperature, may be considered as a limiting factor for obtaining good quality DNA for food traceability (Sakalar, Abasiyanik, Bektik, & Tayyrov, 2012).

Considering aforesaid important issues related to Indian meat cuisine and future implications in food processing sector and meat trade, present study was planned. The overall objective was to test applicability of DNA barcoding to authenticate meat species used in popular Indian culinary practices for meat traceability compliances.

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## Section snippets

### Meat sampling

For food traceability of various meat recipes, common and popular seven Indian culinary practices were selected. Almost all types of meat items fall in these categories as far as food processing methods are concern are shown in Fig. 1. All recipes were processed through professional chefs and cooking temperature, various ingredients used in each recipe are mentioned in Table 1. From these recipes, meat samples were randomly collected in triplicate and preserved in absolute ethanol for further...

### Results

Altogether, ten meat commodities were collected under this study and processed for six traditional Indian meat cuisines (Fig. 1). All processed samples of meat were employed for DNA extraction, where we obtained DNA in reasonable quantity for downstream laboratory applications as shown in Table 3. To assess the effect of various processing methods on DNA, its quality was checked on 1% agarose gel (Fig. 2).

Further, all resultant DNA samples were employed for amplification of cytochrome oxidase...

### Discussions

Over the time, health awareness has increased to several fold and consumers are curious to know the accurate information about the food they consume. In order to keep them informed, regarding their diet and the nature of the food they purchase, food traceability has become important issue (Kang'ehte, Gathuma, & Lindqvist, 1986). The reasons are numerous, but when certain individual is allergic to some food commodity, for religious reason or personal preference, where fraudulent food claims may...

### Conclusion

Certifying the genuinely of food materials used is important to ensure consumers confidence. Authentication is pivotal for legal authorities to detect the ingredients in food products. The obtained results indicated that Indian culinary practices for popular meat recipes although use considerable processing and profound spice, do not interfere meat DNA quality for downstream application for species authentication using DNA barcoding by COI gene. Species authenticity for geographical origin is...

## Funding

This work was supported by the RUSA, Maharashtra under R & I project grant no. RUSA/Release Order/R & I/2016-17/258 (337) Date: 26/07/2016. However, funders do not have any role in study design; data collection; analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication....

## Acknowledgements

We would like to thank RUSA, Maharashtra for financial support under R & I project to Gulab Khedkar (Grant no. RUSA/Release Order/R & I/2016-17/258 (337) Date: 26/07/2016). We are thankful to Prof. Pratima Pawar, Shivaji University Kolhapur, India for collecting pickle samples for this study. We would also like to express our gratitude to Mrs. Manisha Varma and Prof. Vilas Gaikar, State Directorate, RUSA, Mumbai for their valuable suggestions in making this study inclusive. Also authors are...

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...DNA-based sequencing of nuclear genes can help in seafood authentication. Ahmed et al. (2018) confirmed that the use of profound spices and considerable processing according to the Indian culinary practices do not interfere with DNA-based authentication. However, pickled meat products cannot be tracked by DNA-based authentication....

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## [ATR-FTIR spectroscopy combined with DNA barcoding and GC-MS to assess the quality and purity of saffron \(\*Crocus sativus\* L.\)](#)

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...Currently, consumer awareness is growing on food safety, and they are increasingly interested in knowing the source, the origin, and the quality of the foods they eat. For this and in order to keep them informed regarding their diet and the type of food they buy from retailers, food traceability and validation have become key issues [51]. Saffron is one of the most expensive spices used in the food industry and it is highly regarded for its properties of taste, flavor, color, and health benefits....

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## [Modern on-site tool for monitoring contamination of halal meat with products from five non-halal animals using multiplex polymerase chain reaction coupled with DNA strip](#)

2022, Food Control

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...Such incidents have markedly affected the confidence of non-pork eaters in commercially available meat products and created a negative image of consumer protection organizations. Thus, it is of utmost importance to ensure the authenticity of meat and meat products with precise labeling, which will promote confidence regarding their safety among consumers, particularly those having food allergies that might prove to be fatal (Ahmed et al., 2018; Cawthorn et al., 2013). Additionally, the religious beliefs of some individuals do not permit the consumption of certain types of meat....

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## [Multiple tests on saffron find new adulterant materials and reveal that 1st grade saffron is rare in the market](#)

2019, Food Chemistry

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...This can be especially useful when plants sold as spice are processed into small pieces, which substantially hinders morphological identification. DNA barcoding is now recognized as a suitable molecular technology to greatly improve the traceability of several types of food and drinks (Casiraghi, Labra, Ferri, Galimberti, & De

Mattia, 2010; Nadeem et al., 2018; Khedkar, Jamdade, Naik, David, & Haymer, 2014). We recovered high quality amplification products from all but two samples, and the discrimination ability of the rbcL marker was robust with a minimum of 14% variability observed among saffron and its adulterants (Fig. 4), which is quite high as observed under various studies (Casiraghi et al., 2010; Khedkar et al., 2014)....

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## [Food authentication, current issues, analytical techniques, and future challenges: A comprehensive review](#)

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