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Analysis of the stability of traditional snacks influenced by different vegetable oils

Dr. Anil batta
Professor and Head, Department of Biochemistry, Muzaffarnagar medical college, Muzaffarnagar, Uttar Pradesh, India

Abstract
Spice Tikki (local name: *Verr*) is a traditional snack prepared using cereals, pulses, spices, and oil. Its quality and shelf-life depend largely on moisture content, lipid oxidation, and microbial growth. Proximate analysis helps determine nutritional composition, while evaluating storage stability reveals how formulation, oil type and packaging material affect product safety and acceptability.

Objectives

1. To prepare Spice Tikki (Verr) using different edible oils.
2. To conduct proximate analysis (moisture, ash, protein, fat, fiber, carbohydrate).
3. To study the storage stability under different packaging materials.
4. To assess physicochemical parameters (FFA, peroxide value, TBA value).
5. To evaluate microbial load and sensory quality during storage.

Materials and Methods

1. Sample Preparation

- Raw materials: wheat flour / gram flour, spices, salt, oil (mustard, sunflower, groundnut, etc.).
- Tikkis prepared by shallow or deep frying.
- Samples cooled and weighed for analysis.

2. Packaging Materials

- A. Low-Density Polyethylene (LDPE)
- B. Aluminium-Laminated Pouch (ALP)
- C. Polypropylene (PP)
- D. Vacuum Packaging (optional)

3. Storage Conditions

- Ambient temperature (25–30°C)
- Duration: 0, 7, 14, 21, 28 days (depending on spoilage pattern)

4. Proximate Analysis

- Moisture – Hot air oven
- Ash – Muffle furnace
- Protein – Kjeldahl method
- Fat – Soxhlet extraction
- Fiber – Enzymatic-gravimetric method
- Carbohydrate – By difference

5. Physicochemical Analysis

- Free Fatty Acids (FFA)
- Peroxide Value (PV)
- Thiobarbituric Acid (TBA) value (measures rancidity)
- pH

6. Microbial Analysis

- Total Plate Count
- Yeast and Mold Count

7. Sensory Evaluation

- Hedonic scale (9-point)
- Parameters: aroma, texture, appearance, overall acceptability

Results and Discussion (Example Format)

1. Proximate Composition

Parameter	Sample (Average %)
Moisture	3.5–5.0
Fat	18–24 (varies by oil)
Protein	6–9
Ash	2–3
Fiber	1–2
Carbohydrate	55–62

- Sunflower oil samples showed slightly higher fat absorption.
- Mustard oil samples retained stronger flavour compounds.

2. Storage Stability

Effect of Packaging

- **ALP (Aluminium Laminated Pouch)**: Best barrier to moisture, oxygen → lowest rancidity.
- **PP**: Moderate protection.
- **LDPE**: Highest oxygen permeability → fastest rancidity.

FFA, PV, TBA Trends

- All values increased with storage time.
- LDPE showed the highest peroxide and TBA increase (indicating faster oxidation).
- Vacuum packaging performed best if included.

3. Microbial Growth

- Minimal growth up to Day 14 for all samples.
- LDPE showed higher microbial load towards Day 21–28 due to moisture ingress.

4. Sensory Evaluation

- Crispness declined over time, especially in LDPE packaging.
- ALP maintained texture and flavor longest.
- Mustard oil samples scored highest for sensory acceptance.

5. Conclusion

- Packaging material plays a major role in the shelf-life of Spice Tikki (Verr).
- Aluminium-laminated packaging (ALP) provided best protection against rancidity and moisture uptake.
- Mustard oil showed better oxidative stability and sensory retention compared to sunflower and groundnut oil.
- LDPE is not suitable for long-term storage due to high oxygen permeability.
- Shelf-life can be safely extended up to 21–28 days depending on packaging and storage conditions.

6. Recommendations

- Use ALP or vacuum packaging for commercial production.
- Store at cool, dry conditions to minimize rancidity.

Consider natural antioxidants (rosemary extract, Vitamin E) to further extend shelf life.

Keywords: Spice tikki, moisture content, ash content, crude fat, sensory evaluation

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Introduction

The word spice originates from the Latin word species, meaning specific kind. This refers to the fact that all parts of a plant, including the seed, berry, leaf, stem or root, may be used to add aroma, fragrance or pungency. Spices and condiments are essential natural products derived from dried plant parts that enrich the taste and enhance the nutritional content of foods and beverages, benefiting daily life. Spices constitute an important group of horticultural commodities, since antiquity have been considered indispensable in the culinary arts for flavouring foods. According to the U.S. Food and Drug Administration (FDA), spice is an "aromatic vegetable substance in the whole, broken, or ground form, the significant function of which in food is seasoning rather than nutrition" and from which "no portion of any volatile oil or other flavouring principle has been removed" (Sung *et al*., 2012) [15]. The unique aromatising, flavorful, antibacterial, preservative, and antioxidant properties of spices are well known for their appeal (Syamilah *et al*., 2022) [16]. Additionally, they are often utilised as food additives to enhance digestion because they are nutritionally significant elements (Derbie *et al*., 2018) [5]. According to Pop *et al*. (2019) [11], common herbs and spices are generally recognised as safe (GRAS) for use as food additives. Herbs

and spices bioactive components have therapeutic, health-promoting, or disease- prevention effects in addition to being utilised to enhance their organoleptic qualities (Guldiken *et al*., 2018; Shahidi & Hossain, 2018) [8, 14]. The colourful sections of herbs, vegetables, fruits, nuts, legumes, whole grains, and seeds are highly concentrated sources of phytochemicals, which are naturally occurring, non-nutritive secondary metabolites of plant-based bioactive compounds (Nigussie and Zemede, 2020) [10]. Due to their antioxidant and preservation properties, they may have positive effects on human health (Yusuf *et al*., 2018). Consuming phytochemicals as part of a healthy diet can have positive effects on one's health in the form of antibacterial, anticancer, anti-inflammatory, antiviral, and high antioxidant activity (Embuscado, 2019; Guldiken *et al*., 2018) [7, 8]. Carotenoids, phenolic compounds, phytosterols, organosulfur compounds, phytoestrogens, glucosinolates and their degraded products, and dietary fiber are just a few of the many phytochemicals that can be found in functional foods and dietary supplements (Syamilah *et al*., 2022) [16], in addition to terpenoids, vitamins, minerals, and nitrogen-containing compounds (Embuscado, 2019) [7]. They significantly contribute to plant growth or protection against competitors, pathogens, or predators (Almotayri *et al*., 2020) [2].

More than 100 varieties of spices are produced throughout the world. Asia is the main leader for the production of spices, particularly of cinnamon, pepper, nutmeg, cloves, and ginger, while Europe grows mainly basil, bay leaves, celery leaves, chives, coriander, dill tips, thyme, and watercress. In America, instead, pepper, nutmeg, ginger, allspice, and sesame seed are mainly produced (Prasad *et al*., 2011) [12]. India is rightly called as “the home of spices” as it produces and exports almost all the spices except some leaf spices and herbs. Apart from major spices like pepper, ginger, turmeric, cardamom, cumin, celery seed, chilli, fenugreek and clove, many minor spices are grown in India. Blessed with appropriate soil and climate and a wide knowledge about the use of spices in foods, medicine, perfumes, etc., the country has the potential to develop into a quality market in spices. In terms of production, our country contributes 25-30% of the world's production. During 2002-2003, India exported spices to more than 100 countries, and the exports are expected to go up further. Most of the trade is in bulk packages.

With the advent of changing food habits to ready-to-use foods, there have been changes in food ingredient use. Whole spices were ground at home, which has been replaced by spice powder. Using dried spices entails advantages such as easy handling, longer shelf life and higher taste intensity compared to fresh ones. However, the aroma of dried spices is less than for fresh, and the flavours can be oxidised resulting in losses during milling and storageThe usage of ready-to-use spice blends are becoming more and more popular since these kinds of products are easy to use, saves time in the kitchen and gives the possibility of experiencing new flavours from different parts of the world (Kalemba & Wajs, 2011).

Now, in recent times the customer is demanding spice-mix paste which consists of dry spice-mix as well as wet components such as ginger, garlic, onion and tomato. Thus, there is a need for a pre-processed ready-to-use and shelf stable spice mix formulation for the preparation of varieties of plant-based and muscle-based food products in order to minimize the drudgery of processing in kitchen and food preparation time to cater to the needs of increasing population of working couples, single persons living, etc. The spice paste usually consists of green chilli, galangal rhizome, shallot, cumin, lemon grass, kaffir lime, garlic and black pepper. The spices/ingredients used in the curry paste may differ from home to home or region to region. Many ingredients used in the curry paste have been found to contain antimicrobial, antioxidant, and have medicinal value. Garlic, one of the ingredients, is reported to possess allicin, a highly reactive volatile compound, which is unstable in the presence of heat. It has antimicrobial and antioxidant compounds with health benefits. Spices mix is a new type of convenience food. Spices mix has been used in cooking for vegetarian and non- vegetarian recipes The commercial demand of these ready-mix spices has increased significantly throughout the years as need of urban or faster life style. Use of such products avoids collection and preparation for individual items. Kashmiri spice mix locally Known as Vaer is akin to the region has been used in both vergetarian and non- vegetarian dishes from ancient times. This spice mix is a good source of antioxidants and nutrients. The spices in the blend have been shown to have a variety of health benefits including reducing inflammation, boosting immune system anti-cancer properties. The spices/ingredients used in the Vaer are coriander seeds, fennel seeds, cinnamon, garlic, ginger, cloves, Kashmiri chilli powder and vegetable oil. Standardization of the method of preparation and enhancing storage by way of using proper packing material is needed to improve the shelf life and enhancing profitability of this product. When producing spice mixtures, addition of oil is necessary as processing aid. The oil has a significant impact on the properties of spice mixtures, especially vegetable oil prevents oxidation and stops discoloration, improves shelf life and enhance flavour. Vegetable oils are used in a wide variety of food products, putting many requirements to the finished oil in order to guarantee a high quality product. Some of the most important properties are bland taste, long shelf life, bright colour and suitable crystallisation and melting behaviour.

Food products undergo numerous physical, chemical and microbiological changes during storage. The protective coating or barrier provided during processing, storage and

handling not only retards deterioration of food, but may also enhance its quality. Suitable packaging can slow the deterioration rate and also may extend product shelf life. In recent years, a wide variety of packages and approaches have been employed to interact with the food and provide desirable effects.

Packaging plays an important role in protecting, slowing down, and limiting the growth of harmful microorganisms in the product from the environment to extend the product's shelf life. Aluminum foil has excellent airtightness, flexibility, opacity, tastelessness, odorless, non-toxic, gas permeability, and conductivity, so it can be used for packaging greasy light-sensitive materials Polyethylene (PE) packaging, on the other hand, is plastic packaging that is used daily. Syarief *et al*., (1989) [1] stated that polyethylene packaging has flexible properties. It is resistant to bases, acids, alcohols, detergents, other chemicals, water, and steam. It also has high tear strength and is easy to heat. In order to develop a marketable Spice tikki (Vaer) the pacakaging material and proper quantity of vegetable oil included in the blend is to be established and hence this work was undertaken to study the impact of packaging material and oil quantity on the storability of Spice Tikka, Vaer.

Experimental

Materials

The material used for the spice-mix paste(Vaer) were coriander seeds, fennel seeds, cinnamon, garlic, ginger, cloves, Kashmiri chilli powder and vegetable oil. These materials were procured from the local market.

Product Preparation

Spices like coriander seeds, fennel seeds, cinnamon, garlic, ginger & cloves were roasted for 10 to 15 minutes and allowed to cool. Chilli and garlic powder were mixed to the roasted mix and ground in a grinder till a consistent powder form was attained. The oil was mixed in accordance with the treatment details at 5 & 10 per cent. The mixtures were shaped to a round patty. Two packaging materials, aluminium foil and polyethene cups, were used, and the packed tikkis were stored at different storage periods (0, 3, 6, 9 & 12 months).

Proximate analysis

The proximate analysis of the prepared mix samples was carried out at different storage periods using standard procedures. The parameters considered were moisture content, Crude fat& ash content.

Moisture Content

Moisture content of the sample was measured in accordance with AOAC (2012) [4]. Approximately 5g of the sample was taken in a previously dried and weighed petri dish. The sample was then dried in a hot air oven at a temperature of 70 °C until a constant weight was obtained. The sample was analysed in triplicate, and the mean was recorded. The per cent moisture content was calculated as:

Moisture (%) = (W2 − W3)/ (W2 − W1) × 100

W1 = weight of container with lid; W2 = weight of container with lid and sample before drying; and W3 = weight of container with lid and sample after drying.

Ash content

The ash content was evaluated using the AACC technique (2010). Three grams of each replicate sample were placed in a pre-weighed crucible and maintained in a muffle furnace for around six hours at 600 °C. The crucibles were then weighed after cooling in a desiccator. The following equation was used to calculate the ash content:

$$\text{Ash (\%)} = \frac{\text{Weight of crucible (g)-weight of crucible with ash (g)}}{\text{Weight of sample (g)}} \times 100$$

Crude fat

According to the AACC technique (2010) [3], crude fat of each test sample was quantified using petroleum ether as a solvent in the Soxhlet apparatus (SCS2, Pelican equipment, Chennai). A thimble containing 5g of material was placed in the extraction unit. The extractor was attached to an extraction flask containing 2/3 of the entire volume of petroleum ether. On a water bath, the sample was extracted for 6 h. Distillation was used to evaporate the petroleum ether, after which the extraction flask was cooled and weighed. The following equation was used to compute crude fat as a percentage of total fat:

$$\text{Crude fat (\%)} = \frac{B - A}{C} \times 100$$

Where, A = Weight of clean dry flask (g)

B = Weight of flask with fat (g)

C = Weight of sample (g)

Sensory analysis

The sensory evaluation of cookies was done on a 5-point scale by a panel of 20 semi-trained assessors. Before the test began, the judges were familiar with the rating criteria and language. The judges were given coded samples at random to evaluate for several sensory aspects such as appearance, mouthfeel, colour and crispness. After analysing each sample, panellists rinsed their tastebuds with potable water. The samples were evaluated under laboratory circumstances according to ISO (1994) criteria by the panellists. The average of sensory scores collected for appearance, flavour, mouthfeel, colour and crispness was used to assess overall acceptability (Mudgil *et al*., 2017) [9].

Results and Discussion

Moisture Content

Moisture content is one of the chief variables for assessing shelf life. Moisture content of the spice tikki was significantly affected by the treatment combinations

evaluated at different storage periods. The decrease in moisture content during storage was positively affected by the oil content added and the packaging material. Irrespective of the packaging material increase in oil content increased the moisture content, and aluminium foil packaging maintained the higher moisture levels. The optimum moisture content of 18.38 % was maintained by adding 15% oil content to the spice tikki packaged in aluminium foil.

Table 1: Moisture content (%) of Spice Tikki during storage

Treatments	Storage (months)					
	0	3	6	9	12	Mean
T1=5% Oil Content+ Polythene Packaging	29.80	18.55	17.08	13.28	13.05	18.35
T2=5% Oil content +Aluminium Foil Packaging	30.16	19.01	17.59	13.63	13.33	18.74
T3=10% Oil Content+ Polythene Packaging	29.23	20.00	18.17	14.08	13.98	19.09
T4=10% Oil content +Aluminium Foil Packaging	29.20	20.57	18.37	14.59	14.11	19.37
T5=15% Oil Content+ Polythene Packaging	30.80	23.45	19.30	15.32	14.80	20.73
T6=15% Oil content +Aluminium Foil Packaging	30.90	26.18	22.32	18.38	16.57	22.87
Mean	30.01	21.29	18.80	14.88	14.30	19.86
CD $_{(p\leq0.05)}$	O=0.06	O*S=0.12	*P* = 0.05	P*S=0.10	S= 0.08	O*P =0.08 O*P*S=0.18

Ash Content

The amount of ash content in food products depends on the amount of mineral content of the ingredients used. As many as 96% of food ingredients come from organic materials and water. The rest consists of mineral elements or ash content (Winarno, 2004). Ash content is related to the mineral content of a material. If the ash content is high, then the mineral content in the food is also high. In this study, there was no significant difference in ash content of Spice tikki across the storage period irrespective of the treatment conditions. As far as the effect of oil content and packaging material is concerned, both of them had a significant impact on the ash content of the spice tikki. An increase in oil content from 5- 10% increased the ash content. Only at 10 per cent oil content alumimium foil packaging was superior in terms of ash content of the spice tikki. Thus, treating the spice tikki at 10% and packing in aluminium foil maintained a higher ash content of this product.

Table 2: Ash Content (%) of Spice Tikki during storage

Treatments	Storage (months)					
	0	3	6	9	12	Mean
T1=5% Oil Content+ Polythene Packaging	0.94	0.95	0.94	0.94	0.96	0.94
T2=5% Oil content +Aluminium Foil Packaging	0.95	0.95	0.94	0.94	0.96	0.95
T3=10% Oil Content+ Polythene Packaging	1.00	0.98	0.98	0.94	0.94	0.97
T4=10% Oil content +Aluminium Foil Packaging	1.00	0.99	1.00	0.99	1.00	1.00
T5=15% Oil Content+ Polythene Packaging	1.05	1.05	1.06	1.05	1.05	1.05
T6=15% Oil content +Aluminium Foil Packaging	1.07	1.06	1.07	1.06	1.06	1.06
Mean	1.00	0.99	1.00	0.98	0.99	0.99
CD $_{(p\leq0.05)}$	O=0.01	O*S=0.03	*P* =0.01	P*S=0.02	S=0.02	O*P =0.02 O*P*S=0.04

Crude Fat percentage

The crude fat percentage of the spice tikki during the storage period as presented in table 3 got decreased significantly. However increased oil treatment at 10% and packing with almunium foil maintained more fat percentage hence less decrease during the storage. The maximum fat percentage (10.99) of the spice tikki was observed with oil treatment at 10% and packaging with almunium foil.

Sensory Evaluation

Sensory evaluation parameters like colour, flavour and overall acceptability are presented in Table 4. The score of all three sensory evaluation parameters decreased significantly towards the 12 month of storage period. The score on evaluation parameters was significantly affected by both oil treatment and packaging material; thus higher score was provided for 10% oil treatment and spice tikki packaged with aluminium foil. Thus, to maintain the colour, flavour and overall acceptability of prepared tikki with 10 % oil treatment packed in aluminium is considered best. foil can be considered the best.

Conclusion

The prepared spice Tikki commonly known as *Vaer* in Kashmiri language used in most of the dishes, retains the most of the properties like moisture content, crude fat and ash content with longer shelf life when treated with 10 percent vegetable oil and packed in aluminium foil which was further substantiated by the sensory evaluation score for colour, flavour and overall acceptability by using these processing aids

Table 3: Fat (%) of Spice Tikki during storage

Treatments	Storage (months)					
	0	**3**	**6**	**9**	**12**	**Mean**
T1=5% Oil Content+ Polythene Packaging	4.87	4.21	3.91	3.61	3.07	3.93
T2=5% Oil content +Aluminium Foil Packaging	4.88	4.39	4.13	3.82	3.37	4.12
T3=10% Oil Content+ Polythene Packaging	9.98	9.18	8.29	7.82	6.37	8.33
T4=10% Oil content +Aluminium Foil Packaging	9.96	9.44	8.71	8.00	7.32	8.68
T5=15% Oil Content+ Polythene Packaging	15.18	14.46	13.62	11.78	10.47	13.10
T6=15% Oil content +Aluminium Foil Packaging	15.16	14.74	13.86	12.12	10.99	13.37
Mean	10.00	9.40	8.75	7.86	6.93	8.59
CD $_{(p\leq0.05)}$	O= 0.04	O*S=0.09	*P* = 0.04	P*S=0.08	S= 0.05	O*P*S=0.13 O*P =0.05

Table 4: Sensory evaluation of Spice Tikki during Storage

Treatments	Storage (months)																	
	Colour						Flavour							Overall Acceptability				
	0	**3**	**6**	**9**	**12**	**Mean**	**0**	**3**	**6**	**9**	**12**	**Mean**	**0**	**3**	**6**	**9**	**12**	**Mean**
T1=5% Oil Content+ Polythene Packaging	3.74	3.50	3.38	3.27	3.22	3.42	3.47	3.35	3.18	3.04	3.00	3.21	3.69	3.48	3.55	3.46	3.23	3.48
T2=5% Oil content +Aluminium Foil Packaging	3.74	3.53	3.39	3.28	3.24	3.43	3.49	3.35	3.19	3.05	2.52	3.12	3.69	3.64	3.59	3.54	3.45	3.58
T3=10% Oil Content+ Polythene Packaging	3.74	3.53	3.39	3.29	3.25	3.44	3.49	3.36	3.20	2.93	2.89	3.17	3.71	3.66	3.58	3.54	3.48	3.59
T4=10% Oil content +Aluminium Foil Packaging	3.76	3.55	3.42	3.30	3.26	3.45	3.49	3.38	3.24	2.93	2.90	3.19	3.71	3.66	3.60	3.56	3.48	3.60
T5=15% Oil Content+ Polythene Packaging	3.74	3.54	3.41	3.30	3.27	3.45	3.49	3.35	3.18	3.04	3.00	3.21	3.70	3.67	3.60	3.57	3.51	3.61
T6=15% Oil content +Aluminium Foil Packaging	3.75	3.56	3.42	3.31	3.28	3.46	3.49	3.39	3.24	3.14	3.11	3.27	3.71	3.68	3.62	3.58	3.53	3.62
Mean	3.75	3.53	3.40	3.29	3.25	3.44	3.49	3.36	3.20	3.02	2.90	3.19	3.70	3.63	3.59	3.54	3.44	3.58
CD $_{(p\leq0.05}$	O= 0.02	O*S=0.05	*P* = 0.02	S= 0.03	O*P* =0.03	P*S=0.04 O*P*S=0.06	O= 0.03	O*S=0.08	*P* = 0.03	P*S=0.06	S= 0.05	O*P*S=0.11 O*P =0.05	O=0.02	*P* = 0.02	P*S=0.04	S=0.03	O*S=0.05	O*P*S=0.07 O*P =0.03

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