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# Innovation in small ruminants' dairy products in Lebanon: an alternative drying technique for kishk, a traditional fermented milk

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**Abstract.** The Lebanese dairy sector is a viable and competitive sector. However, local dietary habits and consumer expectations of dairy products are changing, with a strong demand for innovative products with better hygienic and nutritional qualities. Consequently, it is essential to valorize traditional dairy products and improve their hygienic and nutritional quality, in order to increase their competitiveness in the Lebanese market and preserve this culinary heritage. Kishk is a traditional Lebanese fermented product, prepared from yogurt and bulgur allowed to ferment together, shaped into balls and sun-dried. However, the sun drying of kishk requires a large amount of manual labor for homogenous drying, and includes a high risk of microbial and physical contamination exists. Therefore, our study proposes an innovative drying technique (hot air drying at 50 °C for 8 h), and evaluates its effects on the nutritional, physicochemical and sensory properties of Lebanese kishk. Results showed that the structure and rheological behavior of kishk powder were not altered, despite slight differences in chemical composition and particle size. Furthermore, kishk soup resulting from the optimized production seems thicker and consistent than traditional soup, without significant loss of the organoleptic properties of kishk. Our results are promising and show that hot air drying technique can be a great alternative to improve the safety of kishk powder while preserving its nutritional and sensory quality.

**Keywords.** Kishk – Lebanese – Traditional – Sun drying – Innovative – Hot air drying.

## *L'innovation dans la filière laitière des petits ruminants au Liban: une technique alternative de séchage du kishk, un lait fermenté traditionnel*

**Résumé.** La filière laitière au Liban est un secteur viable et compétitif. Cependant, les habitudes alimentaires locales et les attentes de base des consommateurs vis-à-vis des produits laitiers évoluent, avec une forte demande pour des produits innovants de meilleures qualités hygiéniques et nutritionnelles. A cet effet, il est essentiel de valoriser les produits laitiers traditionnels et d'améliorer leur qualité hygiénique et nutritionnelle, afin d'accroître leur compétitivité sur le marché libanais et de préserver ce patrimoine culinaire. Le kishk est un lait fermenté traditionnel, à base de yaourt et de boulgour laissés fermenter ensemble, avant d'être façonné en boules et séché au soleil. Le kishk est généralement consommé sous forme de soupe après reconstitution de la poudre avec de l'eau bouillante. Cependant, le séchage du kishk au soleil est très laborieux, et induit un risque élevé de contamination microbienne et physique. Par conséquent, notre étude propose une technique innovante de séchage (séchage convectif par air chaud à 50°C pendant 8 h) et évalue ses effets sur les propriétés nutritionnelles, physico-chimiques et sensorielles du kishk libanais. Les résultats ont montré que la structure et le comportement rhéologique de la poudre de kishk n'ont pas été altérés, malgré de légères différences au niveau de la composition chimique et la taille des particules. Au niveau rhéologique et sensoriel, la soupe de kishk issue de la production optimisée semble plus épaisse et consistante que la soupe traditionnelle, sans dépréciation notable des qualités organoleptiques du kishk. Nos résultats sont prometteurs et montrent que la technique de séchage à l'air chaud peut être une excellente alternative pour améliorer la sécurité sanitaire de la poudre de kishk tout en préservant sa qualité nutritionnelle et sensorielle.

**Mots-clés.** Kishk – Libanais – Traditionnel – Séchage au soleil-innovant – Séchage par air chaud.

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## I – Introduction

Kishk powder is a dried fermented milk-cereal mixture, widely consumed in Lebanon. It is traditionally manufactured by mixing yogurt, bulgur and salt. The obtained dough undergoes a fermentation stage lasting up to 6 days and the mixture is kneaded daily. Then, kishk dough is shaped into small balls and sun-dried. Dried kishk is finally milled into a powder and stored (Tamime *et al.*, 2000; Tamime and O'Connor, 1995). It is usually consumed in the form of a thick soup after reconstitution with boiling water. However, one of the crucial steps in the traditional production of kishk is sun drying, which requires a large amount of manual labor for homogenous drying. It also includes a high risk of microbial and physical contamination, and affects the final quality of kishk powder (Salameh and Hosri, 2016). Recent studies (Salameh *et al.*, 2016; Salameh and Hosri, 2016) characterized this traditional Lebanese fermented product, by determining its chemical composition and evaluating its hygienic quality. An unacceptable amount of contaminants was reported, which can pose a potential hazard to consumers. Consequently, it is necessary to optimize kishk's manufacturing method, and produce it at industrial scale using modern drying techniques, in order to guarantee a healthy and stable product and to improve its competitiveness in the Lebanese market. Therefore, the objective of this study was to evaluate the effect of hot air drying on the nutritional, physicochemical and sensory properties of Lebanese kishk.

## II – Material and methods

### 1. Kishk production

The ingredients used in kishk preparation (white coarse bulgur, full fat yogurt, strained yogurt and salt), and twenty traditional kishk samples were purchased from local markets in Keserwan, Lebanon. The production method of kishk in laboratory conditions using hot air drying was based on a previous study (Salameh, 2012). White coarse bulgur (100 g) was mixed with yogurt (300 g) and the resulting mixture was left to ferment in an incubator at 20 - 25 °C for 36 h. Salt was added to the yogurt/bulgur mixture (2 g salt for 100 g bulgur). Strained yogurt (150 g total) was also added in small amounts during 4 days and the mixture was kneaded daily to encourage fermentation. At the end of the fermentation, kishk dough was cut into small balls of 3 - 5 cm diameter, placed into stainless steel trays, and dried in a convection oven at 50 °C for 8 h. The resulting dry product was ground in a mill and sieved through a 1-mm screen. Kishk powder was stored in glass jars at 4 °C until analysis.

### 2. Chemical analysis

Kishk's composition was determined according to AOAC standard methods (AOAC, 1995). Moisture content was calculated by heating 3 g of each sample to a constant weight in an oven maintained at 105°C. For determination of ash, 3 g of each sample were ashed at 550°C in a furnace until constant weight. Protein was determined by the Kjeldahl method with a conversion factor of 6.25. Fat was obtained by extracting 5 g of each sample in a Soxhlet apparatus using petroleum ether as the extractant.

### 3. Powder flow properties

The powders flow properties were characterized using the FT4 powder rheometer (Freeman Technology, Worcestershire, UK), through compressibility, permeability, aeration, and shear tests, with the 50 mm geometry. Detailed descriptions of this equipment and its use in powder characterization can be found elsewhere.

## 4. Sensory evaluation

A panel of 50 subjects, between 20 and 45 years old, evaluated the sensory properties of kishk soups, and gave scores for color, smell, consistency, acidity, bitterness, aftertaste, mouth-feel, and overall acceptability on a scale from 1 to 9. Kishk soups were prepared by mixing and heating 20 g of Kishk powder with 80 mL water with constant stirring until boiling. The samples were labeled randomly with three digit numerical codes. The cooked samples were served to the panelists in ceramic bowls. Water was provided to the panelists to rinse their mouths between samples.

## 5. Statistical analysis

Data is tested using the SPSS software (version 16.0). Statistical analysis of the results is based on one-way analysis of variance. Statistically significant differences are considered at the level of  $p < 0.05$ .

# II – Results and discussion

## 1. Chemical analysis

Chemical analysis of traditional and hot air dried kishk samples revealed significant differences in protein and fat contents, whereas moisture and ash contents were not significantly affected by the drying method. Fat and protein contents of hot air dried kishk (20.24% and 22.14%, respectively) were higher than those of traditional product (18.15% and 20.25%, respectively). This slight variation may be related to the composition and ratio of ingredients used in kishk formulation. In fact, the composition of kishk powder is strongly dependent on employed ingredients (yogurt, strained yogurt, and bulgur), their ratio, and bulk composition, as well as on the milk type and the fermentation conditions (Erkan *et al.*, 2006; Salameh *et al.*, 2016; Tamime and O'Connor, 1995).

## 2. Powder flow properties

The variation of powder flow properties according to normal stress, through compressibility and shear test, is shown in Figure 1. The rheological behavior of hot air dried and traditional kishk powders was not significantly different. Both powder's types exhibited high compressibility values (Figure 1A) (31.08% and 22.44% at 15 kPa, respectively). They also showed high shear strengths (Figure 1B), revealed by their low friction coefficients ( $< 4$ ). Thus, both kishk powders were considered as cohesive materials, with poor flowability and high compressibility, according to the powders classification (Jenike, 1964).

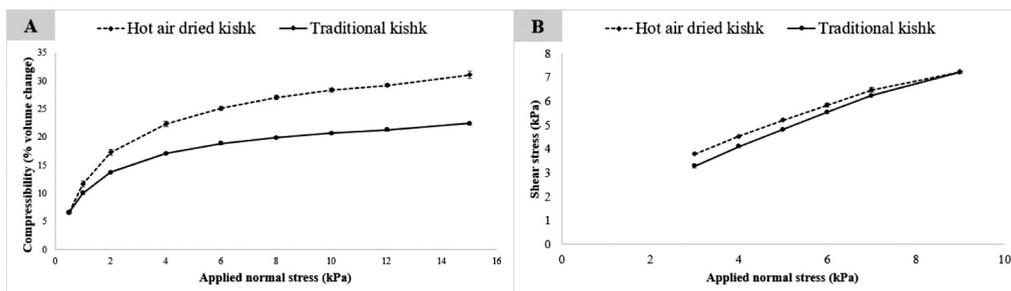


Fig. 1. Variation of kishk flow properties at different applied normal stress (A: powder compressibility test; B: shear test).

In fact, powder flowability is multifactorial: it is not an inherent property of a material, but results from the combined influence of its physicochemical properties (particle size and shape distributions, density, moisture content, composition) and of environmental and processing factors (Prescott and Barnum, 2000). Furthermore, the cohesive character of kishk powder is also related to its broad and bimodal particle size distribution (Salameh *et al.*, 2016). Smaller kishk particles tend to fill the intergranular spaces between larger particles, increasing therefore the contact area between particles and the material compressibility (Bian *et al.*, 2015; Crawford *et al.*, 2016).

Besides, hot air dried and traditional kishk powders were almost insensitive to airflow (Figure 2A) in the tested air velocity range (from 0 to 10 mm/s), as evidenced by their low aeration ratios (1.05, and 1.13 respectively). Both powder's types were physically stable and highly permeable (Figure 2B), due to their large particles of irregular shape, leading to a relatively large porosity, with a pressure drop of 0.39 and 0.24 mbar, respectively.

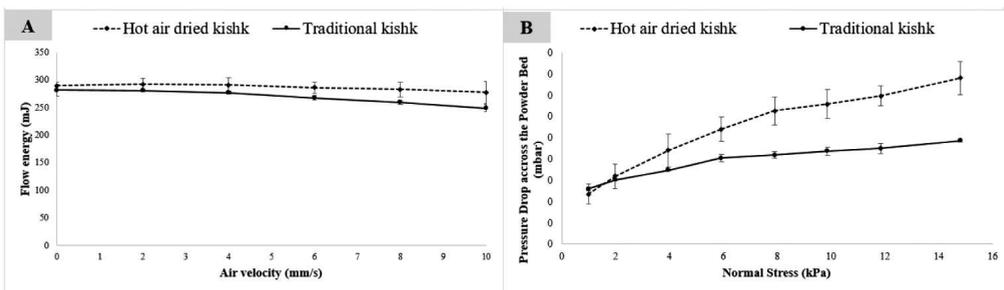


Fig. 2. Variation of kishk flow energy and pressure drop at different applied normal stress and air velocity (A: aeration test; B: permeability test).

### 3. Sensory evaluation of kishk soup

Evaluating the sensory properties of laboratory-made kishk was essential to evaluate the success of using hot air drying to produce kishk, and to identify the weaknesses to resolve in order to get closer to the traditional product. The average scores given by the jury for traditional and hot air dried kishk soups are presented in Figure 3. The latter was significantly more consistent and thick, with a viscous and sticky mouthfeel ( $p < 0.05$ ), unlike the traditional soup that was more heterogeneous and fluid with the presence of particles in suspension.

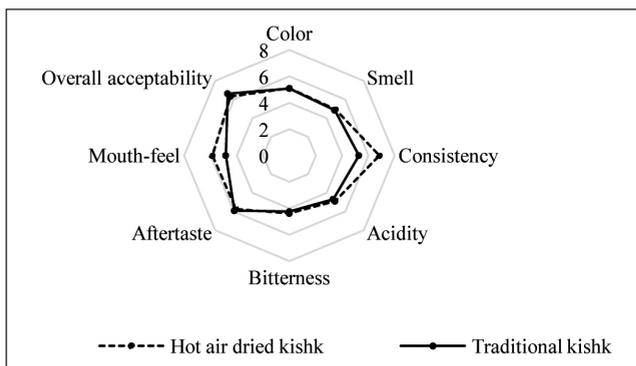


Fig. 3. Sensory properties of traditional and hot air dried kishk.

However, differences in scores for color, smell, acidity, bitterness, aftertaste and overall acceptability were insignificant. Both kishk soups were well appreciated by the evaluation panel, despite a slight preference for the traditional kishk ( $p > 0.05$ ). The acceptability results of laboratory-made kishk are promising; nevertheless they require a better adaptation of the ratio kishk / water to improve the consistency and mouthfeel of kishk soup.

## IV – Conclusion

The aim of this research was to assess the effect of hot air drying on the nutritional, physicochemical and sensory properties of Lebanese kishk. Though fat and protein contents of both kishk types were different, their flow behavior was similar, as powder flowability is multidimensional and depends also on particle shape, surface roughness and structure, and size distribution. Despite these differences, both kishk soups were well appreciated by the evaluation panel and received similar scores for acceptability and other sensory attributes. Therefore, our results are promising and show that using hot air drying is suitable for an industrial application, and can be a great alternative of the traditional sun drying method. Nevertheless, the reconstitution ratio of kishk powder (kishk/water) must be controlled in order to improve the consistency and mouth-feel of kishk soup.

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