

The Roles of Different Sugar Sources on the Quality of Nigella Enriched Tomato Ketchup

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MRT, AA and IJ managed the literature searches and wrote the first draft of the manuscript. Author MAI performed the statistical analysis and wrote the protocol. Author MARM designed the study and overall supervises the research study. All authors read and approved the final manuscript.

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ABSTRACT

The study was concerned to evaluate the effect of table sugar, honey and zero-calorie sugar on the quality of nigella enriched tomato ketchup. Ketchup was prepared by mixing 5, 10 and 15% nigella paste with tomato pulp. The variations in taste, color and texture were analyzed based on the consumers' acceptability and 5% nigella paste was appropriate for product development. Three different types of sugar source (table sugar/honey/zero-calorie sugar) were used to prepare nigella enriched tomato ketchup. Moisture content and total soluble solids (TSS) were significantly lower in the sample S₂ (tomato ketchup prepared with honey) which was 64.00±1.75% and 18.00±1.8%, respectively. Sample S₁ (tomato ketchup prepared with table sugar) contained higher moisture content (65.40±1.55%); though it's not significantly different with sample S₃ (tomato ketchup prepared with zero-calorie sugar). Sample S₃ contained significantly (p<0.05) higher amount of TSS (25±1.6%) than other samples. In case of color analysis, it was observed that L*, a* and b* value reduced for all samples when treated with sodium benzoate but not significantly different. Sensory analysis suggested that sample S₁ was suitable for the processing of nigella enriched tomato ketchup.

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Keywords: *Nigella*; tomato ketchup; table sugar; honey; zero calorie sugar; color.

1. INTRODUCTION

The tomato is the edible, often red, berry of the plant *Solanum lycopersicum* bearing a mildly acid, pulpy fruit commonly known as a tomato plant. The species originated in western South America. In Bangladesh, the area of cultivation is about 13,066 ha with the production of about 74000 m tons. However, the post-harvest losses of tomato at farmers, traders, wholesalers, retailers, processors and consumers level were 9.25, 1.70, 1.98, 3.99, 5.35 and 2.36%, respectively. Total losses after harvest were estimated at 22-23% [1] despite being a fruit, it's generally eaten and prepared like a vegetable. Tomatoes are a dietary source of the antioxidant lycopene, also a great source of vitamin C, potassium, folate (vitamin B9) and vitamin K [2-3]. The tomato is consumed in diverse ways, raw or cooked, in many dishes, sauces, salads, soup, pickle, chutney and drinks. While tomatoes are fruits—botanically classified as berries—they are commonly used as a vegetable ingredient or side dish. *Nigella sativa* (also known as black caraway, black cumin, nigella and kalonji) is an annual spice in the family Ranunculaceae, native to south and southwest Asia and Mediterranean region [4]. *Nigella sativa* grows to 20–30 cm (7.9–11.8 in) tall, with finely divided, linear (but not thread-like) leaves. The flowers are delicate and usually colored pale blue and white, with five to ten petals. Several active compounds found in *Nigella sativa* such as thymoquinone carvacrol, t-anethol and 4-terpineol are responsible for its potent antioxidant properties which protect against cancer, diabetes, heart disease [5]. Ketchup is a sauce used as a condiment and prepared from egg whites, mushrooms, oysters, mussels, or walnuts, among other ingredients [6-7] but now the unmodified term usually refers to tomato ketchup. Ketchup is a sweet and tangy sauce now typically made from tomatoes, sugar, and vinegar, with assorted seasonings and spices. The specific spices and flavors vary, but commonly include onions, all spices, coriander, cloves, cumin, garlic, mustard and sometimes include celery, cinnamon or ginger. Tomato ketchup is most often used as a condiment to dishes that are usually served hot and maybe fried or greasy: French fries, hamburgers, hot dogs, chicken tenders, tater tots, hot sandwiches, meat pies, cooked eggs, and grilled or fried meat. Ketchup is sometimes used as the basis for or as one ingredient in, other sauces and dressings and the flavor may be replicated

as an additive flavoring for snacks such as potato chips. World population is nearly 7 billion demands for huge amount of food supply with proper nutrient. In the developing country, people are suffering from malnutrition and chronic disease. Therefore, a new alternative forms of food products an attractive market around plant-based products in food industry is needed. Tomatoes are the primary ingredient in many products such as sauce, ketchup, chutney, pickle and soup etc. This research aimed to develop nigella enriched tomato ketchup and evaluate its quality.

2. MATERIALS AND METHODS

2.1 Materials

Fresh tomato and nigella seed were collected from the local market (Mymensingh). All spices indicated in Table 1 and vinegar was purchased from the local market (Mymensingh).

Table 1. Ingredients required for the preparation of ketchup

Serial No.	Ingredients	Quantity
1.	Tomato	212 g
2.	Nigella paste	38 g
	Sugar	50 g
3.	Honey	55 g
	Zero- cal	0.6 g
4.	Salt	5.0 g
5.	Onion	9.5 g
6.	Red chili	1.2 g
7.	Garlic	5.4 g
8.	Cinnamon	1.1 g
9.	Clove	0.3 g
10.	Cardamom	0.3 g
11.	Black pepper	0.2 g
12.	Vinegar	50 cc
13.	Sodium-benzoate	167 ppm

2.2 Sample Preparation

2.2.1 Preparation of tomato pulp

At first tomatoes were washed and cleaned. Then cut into pieces and steamed at low temperature (70-90°C). After steaming tomatoes were cooled and then blended. Then pulp was filtered to collect tomato pulp.

2.2.2 Preparation of Nigella paste

Nigella seeds were cleaned then blended for paste preparation. Prepared paste was used in tomato ketchup.

2.2.3 Selection of tomato pulp and nigella paste mixture for the design of nigella enriched tomato ketchup

Firstly, tomato pulp and nigella paste were mixed as per formulations:

- P1: Tomato pulp 95% +5% Nigella paste
- P2: Tomato pulp 90% +10% Nigella paste
- P3: Tomato pulp 85% +15% Nigella paste

After that 50 g of sugar was mixed with each formulation. Finally, sensory evaluation was performed for consumer acceptance.

2.2.4 Preparation of nigella enriched tomato ketchup

Tomato pulp and nigella paste were mixed in a pan. The mixture was then cooked with one-third of table sugar/ honey/ zero-cal sugar and salt to prepare three samples S₁, S₂ and S₃. All spices bag was dipped into bowl and pressed occasionally. Spices bag was removed when cooked to one-third of the original volume of pulp and nigella paste mixture. Then remaining white sugar/ honey/ zero-cal sugar and salt was added carefully and cooked. When the volume was viscous enough and TSS was about 22-25%, vinegar and sodium benzoate added to the ketchup. Finally, sample S₁, S₂ and S₃ were prepared.

where,

- S₁ = Nigella enriched ketchup prepared with table sugar,
- S₂ = Nigella enriched ketchup prepared with honey;
- S₃ = Nigella enriched ketchup prepared with zero-calorie sugar

2.3 Analysis of Nigella Enriched Tomato Ketchup

2.3.1 Moisture content

Moisture content was determined to adopt AOAC method [8].

Moisture content was determined by placing an accurately weighed known amount sample in a pre-weighted porcelain crucible in an electric oven at 105°C for 24 hrs. After drying, the crucible was removed from the oven and cooled in a desiccator. It was then weighted with a cover glass. Drying cooling and weighting were repeated until a constant weight was obtained.

The loss of moisture was calculated as present moisture. The formula is mentioned below:

$$\% \text{ of moisture} = \frac{W_1 - W_2}{W_1} \times 100$$

where,

W₁ = Crucible + Sample weight (g)

W₂ = Crucible + Dry sample weight (g)

2.3.2 Total soluble solids (TSS)

TSS content of nigella rich ketchup was determined by using a refractometer. A drop of ketchup was placed on the prism of refractometer. Percent TSS was obtained from a direct reading of the instrument. Temperature correction was made by using the methods described by Ranganna [9].

2.3.3 Color measurement by chromameter

Color of the nigella rich ketchup was measured by the modified method describe Ahmed et al. [10] using a Minolta colorimeter (Hunter Associates Laboratory, Inc., Reston, VA, USA). Results were analyzed according to the CIELAB system with reference to illuminant D65 and a visual angle of 10°. The parameters determined were L* (luminosity or brightness: L* = 0; black and L* = 100; white), a* (red-green component: - a* = greenness and +a* = redness) and b*(yellow-blue component: - b* = blueness and +b* = yellowness). Where L*, a* and b* values at the considered storage time were considered with respect to those obtained in just manufactured samples (time zero). All analyses were performed in duplicate.

2.4 Sensory Evaluation

The consumer acceptability of developed products was evaluated by a testing panel. The panelists were untrained and selected from the students, teachers and employees of the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh. The panelists (06) were asked to assign an appropriate score to each product tested on a 1 to 9-point hedonic scale [11] for characteristics of color, flavor, texture and overall acceptability of three samples of nigella enriched tomato ketchup.

The scale was arranged such that: 9= like extremely, 8=like very much, 7= like moderately, 6=like slightly, 5=neither like or dislike, 4, =dislike

slightly, 3=dislike moderately, 2=dislike very much and 1=dislike extremely.

3. RESULTS AND DISCUSSION

3.1 Consumer Preference for Selection of Tomato Pulp and Nigella Paste

For the selection of tomato pulp and nigella paste, a sensory evolution was conducted and the result was shown in Table 2. Table 2 suggested that there is a significant difference among all three samples in case of both flavor and taste. Sample P₁ showed better consumer preference in terms of flavor of nigella ketchup. Bitterness increased with increasing the nigella paste in the tomato ketchup. A similar trend was also observed for color, increasing the nigella paste in increased the black color in the tomato ketchup. This study suggested that sample P₁ (95% tomato pulp + 5% nigella paste) is suitable for the processing of tomato ketchup enriched by nigella.

3.2 Moisture and TSS Content of Nigella Enrich Tomato Ketchup

Table 3 suggested that moisture content of sample S₂ was significantly ($p < 0.05$) lower than

sample S₁ and S₃ though honey contains more moisture (17-18)% [12] than table sugar and zero-cal sugar. However, there was no significant difference between sample S₁ and S₃. The results were in an agreement with Anandsyal et al. [13], who found 59-65% moisture content of market available ketchup in Bangladesh.

Table 3 also indicated that TSS content of nigella enrich tomato ketchup was 18 -25%. The result was in agreement with Nasir et al. [14], who found the moisture content of tomato ketchup was 25 to 26%. However, TSS of tomato ketchup usually remains in a range of 22-25% [15].

3.3 Color Parameter for Nigella Enriched Tomato Ketchup

Fig. 1 illustrated that honey contains nigella enriched tomato ketchup showed significantly higher brownish color than sugar and zero-cal containing tomato ketchup. This might be due to non-enzymatic browning of honey during heat treatment [16]. On the other hand, there was no significant difference among all three samples with or without sodium benzoate. Sodium benzoate might be effective in case of microbial analysis but not for color parameter of nigella enriched tomato ketchup.

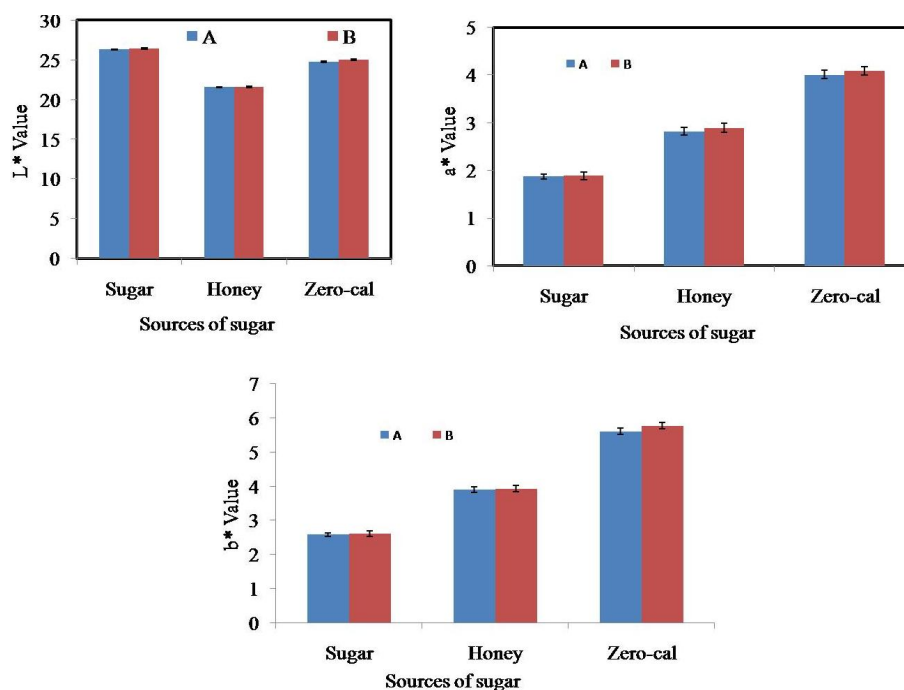


Fig. 1. Color parameter for the nigella enriched tomato ketchup. A = Samples with sodium benzoate, B = Samples without sodium benzoate. Bar represents standard deviation

Table 2. Sensory scores for selection of tomato pulp and nigella paste

Sensory description	Samples		
	P ₁	P ₂	P ₃
Flavor	6.45 ^c	5.75 ^b	2.55 ^a
Taste (Bitterness)	7.00 ^c	6.50 ^b	3.15 ^a
Color	5.50 ^c	4.50 ^b	2.15 ^a

*P₁=Tomato ketchup made with 5% nigella, P₂=Tomato ketchup made with 10% nigella, P₃=Tomato ketchup made with 15% nigella

Table 3. Moisture percentage of nigella enriched tomato ketchup

Components	Ketchup prepared with sugar (S ₁)	Ketchup prepared with honey (S ₂)	Ketchup prepared with zero-cal (S ₃)
Moisture (%)	65.40 ^a ±1.55	64.00 ^b ±1.75	65.35 ^a ±2.00
TSS (%)	24.7 ^a ±1.50	18.0 ^b ±1.80	25.0 ^a ±1.60

Table 4. Mean score for color, flavor, texture and overall acceptability

Sample type	Sensory attributes			
	Color	Flavor	Texture	Overall acceptability
* S ₁	8.571 ^a	8.143 ^a	8.43 ^a	8.142 ^a
S ₂	8 ^a	8.143 ^a	7.43 ^a	6.29 ^b
S ₃	7.714 ^a	7 ^a	8.28 ^a	6.57 ^b
LSD P<0.01	-	-	-	1.259

* S₁= Tomato ketchup made with table sugar, S₂= Tomato ketchup made with honey, S₃= Tomato ketchup made with zero-calorie sugar

3.4 Sensory Characteristics of Nigella Enriched Tomato Ketchup

The samples of ketchup enriched with nigella were subjected to sensory evaluation. The color, flavor, texture and overall acceptability of ketchup were evaluated by a panel of 7 judges.

In case of color preference, Table 4 indicated that there was no difference among all three samples. For flavor and texture preference, the above result suggested that there was no difference among all three samples. However, sample S₁ (Nigella enriched tomato ketchup with sugar) showed better acceptability (P<0.01) than other samples.

4. CONCLUSION

Nigella enriched tomato ketchup containing table sugar was accepted by the panelist. Using of honey in tomato ketchup as a source of sugar gave more brownish tomato ketchup than other sources of sugar. Tomato ketchup with nigella paste could be a better option for the producers to avail the health benefits of nigella to the consumer. While, 5% nigella paste could be appropriate for the processing of nigella enriched

tomato ketchup. However, research on shelf-life and consumer's preference of nigella enriched tomato ketchup with market available tomato ketchup is needed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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