# Fortification of Balady Bread with Tomato Seed Meal

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**ABSTRACT**

Tomato seed meal prepared from tomato processing wastes was used as a protein source in the preparation of Egyptian balady bread. Whole and defatted tomato seed meal was added at 5, 10, and 15% wheat flour replacement levels. The influence of this addition on the rheological gas production of the dough, as well as on the organoleptic and chemical properties of balady bread, was studied. High amounts of fat and protein in whole tomato seed meal were found. Water absorption, dough development time, and dough stability were improved by increasing the level of supplementation. Defatted tomato seed meal decreased the mixing tolerance index and the dough weakening, compared with those of whole meal. Extensigraph results indicated that dough extensibility, resistance to extension, and dough energy were minimized with increasing tomato seed meal in the formula containing wheat flour. Adding tomato seed meal improved gas production, moisture content, and the diameter of the loaf after baking. Organoleptic evaluation showed that balady bread with less than 10% tomato seed meal received a fancy grade, but more than this resulted in crust and crumb darkening.

The processing of many fruit and vegetable products generates waste, which could contribute to environmental pollution. Although the food industry has a good record of developing by-products, improvement is possible. The tomato processing industry serves as an excellent example (Altschul 1985). Carlson et al (1981) reported that tomato seeds, an abundant waste product in tomato processing, contain high amounts of crude fat and protein. They also showed that tomato seed protein is especially high in lysine, the limiting amino acid of cereal products, and that the supplementation of wheat flour bread at the 10 and 20% levels increased lysine by 40.2 and 69.0%. Tomato seeds, which make up 55% of canning waste, were previously reported to contain 28.4–31.0% protein, 36.0–37.9% fat, and 5.0–6.5 g/16 g of N (Canella et al 1979).

Wheat breads baked with the addition of 1 or 2% tomato seed flour (produced on a laboratory mill) to the wheat flour were equal in quality to the control wheat bread, but greater additions resulted in crumb darkening. Tests with rye flour showed that adding 7% tomato seed flour resulted in bread of very good quality, with greater volume and porosity than the control bread (Mokhnacheva et al 1975). They also noticed that this addition increased protein content by about 14% and lysine content by about 75%. These investigators strongly recommend the use of tomato seeds in breadmaking. Brodowski and Geisman (1980) reported that tomato seed protein contains approximately 13% more lysine than soy protein, which would allow it to be used in fortifying foods low in lysine content.

The magnitude of the protein problem in Egypt has directed research toward the reevaluation of the various natural sources of protein in an attempt to improve the quality and quantity of individual protein intake. In Egypt, bread is the principal food and a staple for a great majority of the population, constituting 70% of the daily caloric intake of the average Egyptian. Thus, the present study was designed to shed light on the chemical composition of tomato seed meal, as well as on the use of tomato seed meal, in the production of Egyptian balady bread. The effects of adding tomato seed meal to wheat flour on the rheological gas production of dough and the organoleptic characteristics of balady bread were also studied.

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## MATERIALS AND METHODS

American wheat flour (82% extraction) was purchased from the El-Remaly mill in Cairo; tomato seeds were obtained from the El-Naser company (Kaha), Egypt.

### Preparation of Tomato Seed Meal and Flour Blends

Tomato seeds were cleaned, dried, and then milled with a Brabender Quadrumat Junior mill. The meal was divided into two portions. A portion of whole meal was extracted by diethyl ether and then air dried. Whole and defatted tomato seed meal was blended with wheat flour at the 5, 10, and 15% levels. All samples were stored in airtight containers and kept at 1–2°C until required.

*Breadmaking techniques.* Balady bread was prepared by mixing 100 g of flour (82% extraction), 0.5 g of yeast (dried), 1.5 g of sodium chloride, and 75–80 ml of water in a farinograph for 6 min. The dough was left to ferment for 1 hr at 30°C and 85% relative humidity and was then divided into 125-g pieces. The pieces were arranged on a wooden board that had been sprinkled with a fine layer of bran and were left to ferment for about 45 min at the same temperature and relative humidity. The pieces of fermented dough were flattened to be about 20 cm in diameter.

**TABLE I**
**Analysis of Tomato Seed Meal and Wheat Flour (%, dry weight basis)**

| Sample | Moisture | Protein | Fat | Fiber | Ash |
|---|---|---|---|---|---|
| Wheat flour | 11.20 | 10.90 | 1.82 | 1.46 | 1.86 |
| Whole tomato seed meal | 5.28 | 32.43 | 26.28 | 21.40 | 3.85 |
| Defatted tomato seed meal | 7.10 | 42.16 | 1.20 | 30.57 | 5.08 |

TABLE II
Farinograph Parameters of Wheat Flour Dough and Tomato Seed Flour Blends

| Sample | Water Absorption (%) | Dough Development Time (min) | Dough Stability (min) | Mixing Tolerance Index (BU) | Dough Weakening (BU) |
|---|---|---|---|---|---|
| Control | 57.5 | 3.2 | 6.5 | 60 | 70 |
| Whole tomato seeds (%) | | | | | |
| 5 | 57.7 | 4.3 | 8.2 | 90 | 65 |
| 10 | 58.1 | 3.5 | 7.0 | 80 | 75 |
| 15 | 58.3 | 3.5 | 5.7 | 70 | 82 |
| Defatted tomato seeds (%) | | | | | |
| 5 | 58.1 | 4.5 | 9.0 | 75 | 70 |
| 10 | 58.8 | 4.5 | 8.6 | 70 | 60 |
| 15 | 59.8 | 4.5 | 8.4 | 50 | 67 |

TABLE III
Extensigraph Parameters of Wheat Flour Dough and Tomato Seed Flour Blends

| Sample | Extensibility (mm) | Resistance to Extension (BU) | Dough Energy ($cm^2$) | Proportional Number[a] |
|---|---|---|---|---|
| Control | 110 | 430 | 85.75 | 3.90 |
| Whole tomato seeds (%) | | | | |
| 5 | 98 | 400 | 81.50 | 4.08 |
| 10 | 87 | 375 | 72.00 | 4.31 |
| 15 | 77 | 347 | 63.80 | 4.51 |
| Defatted tomato seeds (%) | | | | |
| 5 | 92 | 408 | 79.00 | 4.43 |
| 10 | 73 | 400 | 65.90 | 5.48 |
| 15 | 71 | 377 | 57.00 | 5.31 |

[a] Resistance to extension divided by extensibility.

TABLE IV
Effect of Adding Tomato Seed Meal to Wheat Flour on Gas Production

| Sample | Gas Production (mm of Hg, in min) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 |
| Control | 0 | 10 | 28 | 58 | 112 | 158 | 206 | 256 | 284 |
| Whole tomato seeds (%) | | | | | | | | | |
| 5 | 0 | 16 | 42 | 82 | 132 | 178 | 230 | 286 | ··· |
| 10 | 0 | 16 | 45 | 88 | 150 | 200 | 255 | 296 | ··· |
| 15 | 0 | 18 | 58 | 110 | 166 | 226 | 290 | ··· | ··· |
| Defatted tomato seeds (%) | | | | | | | | | |
| 5 | 0 | 14 | 34 | 64 | 115 | 162 | 215 | 265 | 290 |
| 10 | 0 | 14 | 34 | 74 | 116 | 168 | 220 | 278 | 295 |
| 15 | 0 | 15 | 33 | 78 | 116 | 170 | 222 | 283 | 298 |

The flattened loaves were proofed at 30–35°C and 85% relative humidity for 15 min and then were baked at 400–500°C for 1–2 min. The loaves of bread were allowed to cool on racks for about 1 hr before evaluation.

*Analytical methods.* Moisture, ash, protein, crude fiber, and fat were analyzed according to AOAC methods 14.004, 14.006, 2.057, 7.065, and 14.018 (AOAC 1980). Evidence of gassing power was based on the AACC manometric method 22-11 (AACC 1962). Rheological properties of the doughs were analyzed with an extensigraph and a farinograph according to AACC methods 54-10 and 54-21, respectively (AACC 1962).

Ten panelists were asked to evaluate bread for appearance, separation of layers, roundness, crumb distribution, taste, odor, and crust color according to the method of Kramer and Twigg (1974).

Whole and defatted tomato seed meal and wheat flour were analyzed for total protein, total lipids, moisture, crude fiber, and ash content.

## RESULTS AND DISCUSSION

### Chemical Analysis of Tomato Seed Meal and Wheat Flour

Percents of protein, fat, crude fiber, and ash in the whole tomato seed meal were higher than those in wheat flour (Table I). These values agreed with those reported by Rakhmetova (1980), who found that the total protein and fat of tomato seed were 32.0 and 25.5%, respectively.

### Rheological Properties of the Dough

*Farinograph test.* Absorption, dough development time, and stability increased when whole or defatted tomato seed meal was blended with wheat flour (Table II). However, within blends, as the level of whole and defatted tomato seed meal increased, the dough stability and mixing tolerance index decreased.

*Extensigraph test.* The substitution of tomato seed meal for wheat flour decreased extensibility, resistance to extension, and dough energy of the wheat flour (Table III). The proportional number increased as the percentage of whole or defatted tomato seed meal increased.

### Gassing Power Test

Experiments proved that the addition of whole or defatted tomato seed meal to wheat flour increased gas ($CO_2$) production (Table IV). The fermentation time for blended whole and defatted tomato seed meal with wheat flour at a 15% replacement level decreased by 25.0 and 12.5%, respectively. The higher gas production or shorter fermentation time may be due to the fermentable sugars in the added tomato seed meal.

### Baking Test and Organoleptic Qualities of Balady Bread

The supplementation effects of tomato seed meal on balady bread quality are shown in Table V. A slight increase in loaf weight occurred after baking due to the enhanced absorption of moisture (Table II). Loaf diameter also improved as a result of adding 10% or more of tomato seed meal to the dough formula. With respect to the organoleptic evaluation of the bread produced, the overall quality correlates with the ratio of the tomato seed meal (Table V). The 5 and 10% recipes received a fancy grade in quality measurements as described by Kramer and Twigg (1974), while the other recipe (15%) received an extra standard grade in quality. The crust and crumb of the breads fortified with 5% tomato seed meal were golden; at higher levels of supplementation, they were darker. These results are in agreement with those of Mokhnacheva et al (1975). They reported that wheat breads baked with 1 or 2% tomato seed flour added to wheat flour were equal in quality to control wheat bread, but greater additions resulted in crumb darkening.

Taste scores decreased as the level of tomato seed meal increased. A slightly bitter taste at a 10% or greater replacement level may be due to a steroid compound found in crushed tomato seed (Zagibalov et al 1985).

### Effect of Baking and the Addition of Tomato Seed Meal on Major Chemical Constituents of Balady Bread

Table VI shows the chemical composition of balady bread prepared from wheat flour with the addition of tomato seed meal. The protein content of the control bread was higher than that of the wheat flour (Table I), which may be attributed to the presence of bran coating on the bottom of the loaves or to the added quantities of yeast. Tomato seed meal is characterized by its high protein content. As expected, therefore, the protein

TABLE V
Measurements and Quality Characteristics of Balady Bread Made with Wheat Flour/Tomato Seed Meal Blends

| | Control | Whole Tomato Seed Meal | | | Defatted Tomato Seed Meal | | |
|---|---|---|---|---|---|---|---|
| | | 5% | 10% | 15% | 5% | 10% | 15% |
| Measurement | | | | | | | |
| Weight after baking (g) | 94.0 | 94.0 | 95.0 | 95.8 | 95.0 | 95.6 | 97.0 |
| Moisture content (%) | 34.0 | 34.4 | 35.0 | 36.0 | 35.5 | 36.3 | 37.0 |
| Diameter after baking (cm) | 17.5 | 17.5 | 18.0 | 18.5 | 17.5 | 18.5 | 18.0 |
| Quality | | | | | | | |
| General appearance (20) | 17.6 | 17.5 | 17.2 | 16.4 | 18.4 | 17.5 | 11.9 |
| Separation of layers (20) | 18.0 | 18.2 | 18.1 | 16.6 | 19.0 | 17.7 | 14.0 |
| Roundness (15) | 13.7 | 13.8 | 13.7 | 13.1 | 14.3 | 12.6 | 10.0 |
| Crumb distribution (15) | 13.6 | 14.2 | 13.8 | 12.8 | 14.3 | 13.6 | 10.8 |
| Taste (10) | 8.3 | 7.4 | 6.8 | 5.6 | 8.6 | 5.9 | 4.1 |
| Odor (10) | 8.0 | 8.1 | 7.7 | 7.1 | 8.9 | 7.6 | 6.4 |
| Crust color (10) | 7.9 | 7.5 | 7.8 | 7.2 | 8.8 | 7.4 | 5.4 |
| Overall quality (100) | 87.1 | 86.7 | 85.1 | 78.8 | 88.7 | 82.3 | 62.6 |

TABLE VI
Major Chemical Constituents of Balady Bread Made from Wheat Flour plus Tomato Seed Meal (%, dry weight basis)

| Sample | Protein | Fat | Fiber | Ash |
|---|---|---|---|---|
| Control | 11.40 | 1.34 | 1.72 | 2.20 |
| Whole tomato seeds (%) | | | | |
| 5 | 12.62 | 2.21 | 2.60 | 2.30 |
| 10 | 13.50 | 3.43 | 3.55 | 2.42 |
| 15 | 14.71 | 4.00 | 4.63 | 2.50 |
| Defatted tomato seeds (%) | | | | |
| 5 | 13.00 | 1.23 | 2.81 | 2.39 |
| 10 | 14.72 | 1.18 | 3.92 | 2.48 |
| 15 | 16.22 | 1.00 | 5.10 | 2.60 |

content of the bread samples was increased as a result of the addition of tomato seed meal. The same trend was also noticed for the ash and fiber contents and probably could be explained by the fact that tomato seed meal contains high levels of ash and crude fiber.

It was also noted that the addition of whole tomato seed meal to wheat flour resulted in a large increase in the fat content of the bread, while the addition of defatted tomato seed meal lowered the fat content.

Based on these results, it could be recommended that tomato seed be used to supplement wheat flour in making balady bread.

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