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# DRUM DRYING FOR THE IMPROVED PRODUCTION OF INSTANT TORTILLA FLOUR

## ABSTRACT

The present industrial production of tortilla flour is virtually an extrapolation of the home process, involving a cooking and drying operation as the main energy expenditures and costs. The possibility of preparing an acceptable instant tortilla flour, by means of other technologies, was therefore explored. Whole raw corn flour was mixed with water (ratio of 3:1) and lime (0.3% of the corn flour weight). This dough was then passed through a double-drum drier. With a drum opening of 0.003 in. ($7.62 \times 10^{-3}$ cm), it was found that the use of an internal pressure of either 15, 20 or 25 psig (93, 99 and 104°C surface temperature, respectively) at 2, 3 or 4 rpm, produced an instant tortilla flour with physicochemical and organoleptic characteristics identical ($P < 0.05$) to those of the reference sample prepared by hand. In contrast, commercial samples of a similar product proved to be different ($P < 0.05$) from the standard and from the product obtained with the drum drier, both from the physicochemical and organoleptic standpoints. Economically, the new process indicated that it was not only feasible, but that it also can allow for the supplementation of tortilla at the industrial level.

## INTRODUCTION

ALTHOUGH the industrial production of precooked tortilla flour in the Central American region has been in existence for almost two decades (Gámez Duch, 1972), the current technology used in this industry has been an adaptation of the home method for the preparation of tortillas (Bressani and Scrimshaw, 1958; Gámez Duch, 1972). The present technology for the industrial manufacture of instant tortilla flour has two operations requiring a high energy input. These are the cooking of the corn and the dehydration of the cooked corn dough. These two steps are also responsible for a relatively large proportion of the processing costs of the product (Gámez Duch, 1972).

Tortillas are a common staple of the Central American diet. Therefore, they have been regarded as a very promising vehicle for the fortification and/or enrichment of the Central American diet (Elías and Bressani, 1972; Mata et al., 1972). These operations could be more easily and effectively controlled if they were carried out during the manufacture of an instant tortilla flour (Molina et al., 1972). However, at present the production costs of this product do not allow for a fortification and/or enrichment operation without increasing the price of the final product.

This study was undertaken to determine the feasibility of preparing an acceptable instant tortilla flour through the application of drum drying technology which would permit lowering production cost.

## MATERIALS & METHODS

THE CORN (*Zea mays*) used in the present study was a white variety grown in the lowlands of Guatemala (244m above sea level), and corresponded to the 1974 crop.

Home cooking of the corn to prepare the standard tortilla dough ("masa") was carried out as described by Bressani and Scrimshaw, (1958). This standard corn masa was then freeze dried and milled to provide a reference instant tortilla flour.

Unless otherwise specified, all the milling operations were carried out in a hammer mill equipped with a 40-mesh screen. A double-drum drier with a total drying surface of 2 sq ft (General Food Package Equipment Corp., GF series, Model 215) was used. The calcium hydroxide or lime utilized throughout the study was of the commercial type generally used for the home preparation of tortillas.

Moisture, ash, ether extract, crude fiber, nitrogen, starch and calcium determinations were carried out in duplicate according to the AOAC (1970). Protein was calculated by multiplying the nitrogen content by the customary conversion factor, 6.25. Total sugars were determined by the phenol-sulfuric method as described by Dubois et al. (1956) and were expressed as glucose. Available lysine determinations were performed following the method of Conkerton and Frampton (1959). The damaged starch content was established according to Farrand (1964) and the sedimentation value according to Zeleny (1947).

The amylographic viscosity of the flours was measured using a Brabender amylograph (Model AV-10), and the method of the AACC (1969). In all instances, 60g of sample (14% moisture basis) were used for the test and no malt flour was added. The total amount of buffer reagent used was 460 ml.

The water absorption capacity of the flours was determined in a Brabender farinograph by the method of the AACC (1969). All tests were carried out with 300g of sample (14% moisture basis). No malt flour was added for this test. The water absorption was determined in all instances at a standard maximum resistance value of 300 Brabender Units (B.U.). All determinations were in triplicate.

The organoleptic evaluation of the tortillas prepared with the precooked flours was carried out using the triangle method described by Kramer and Twigg (1966), and a panel of 10 semitrained individuals. All samples were prepared at the same time and presented under equal conditions. The triangle test was replicated twice.

Statistical analyses of the data were carried out by the "t" test and by the multiple "F" test as described by Snedecor and Cochran (1967).

## RESULTS & DISCUSSION

THE PERCENT COMPOSITION (on "as is" basis) of the home-cooked, reference corn dough ("masa") is presented in Table 1. The calcium content of the dough (126 mg %) is very high when compared with the average value (4 mg %) reported for raw corn, but is similar to that reported for lime-treated corn dough and its products (Bressani et al., 1958). This characteristic has made the tortilla nutritionally valuable as a source of calcium for the consuming populations (Bressani, 1972). The damaged starch content of the corn dough is relatively high (57.1%, equivalent to 88.6% of the total starch), indicating the partial gelatinization of the cornstarch during the process. The available lysine content reported here for the dough studied is very similar to values in the literature for similar corn products (Elías and Bressani, 1972).

Some physicochemical characteristics of the home-cooked reference dough are presented in Table 2. During the experiments it was observed that the maximum amylographic viscosity value attained was indicative of the degree of cooking of the grain and of the degree of cohesion and, possibly also of the undesirable chewiness of the dough in the preparation of tortillas. The average cooking time for the common white corn used in the experiments, was 50 min. The average water absorption and Zeleny sedimentation values obtained for the dough prepared are also given in Table 2.

Figure 1 illustrates a typical amylographic curve obtained for the freeze-dried, home-cooked common white corn used in our study.

Considering that the damaged starch content of a corn sample can determine to a large extent its maximum amylographic viscosity (Molina et al., 1976b) and that this, in turn, in our laboratory has been observed to be an index of its adequacy for tortilla manufacture, it was thought possible to effect both the damage of the starch (that normally occurs through the cooking operation) and the drying of the cooked corn dough in a single operation. This possibility was prompted by analogous experience in the development of a process for the utilization of corn and legume seed flours in pasta manufacture (Molina et al., 1976a), with the intent of saving the energy which presently is utilized in separate cooking and drying operations. Accordingly, in the present case the drum drier was chosen to effect the starch damage and drying operations at the same time.

Preliminary experiments revealed that when 300g of raw white corn flour (approx 80 mesh) were mixed with 100 ml of a 0.3% $Ca(OH)_2$ solution, a suitable dry instant tortilla flour could be obtained by passing the raw corn dough through a double-drum drier at 2–4 rpm, using an internal pressure of either 15, 20 or 25 psig (equivalent to 93, 99 and 104°C surface temperature, respectively) and a drum opening of 0.003 in. (or $7.62 \times 10^{-3}$ cm).

The percent composition of the instant tortilla flour obtained through the double-drum drier using an internal pressure of 20 psig (99°C surface temp) is detailed in Table 3. The composition of two different locally produced, commercial instant tortilla flours is also included. As observed, the concentration of all nutrients is very similar except for calcium and damaged starch where the commercial samples "A" and "B" show a significantly ($P < 0.05$) lower value than the drum-dried and the home-cooked samples (Table 1).

Some physicochemical characteristics of the instant tortilla flour obtained through the drum-drier process and of the two commercial samples of a similar product are presented in Table 4. The commercial samples "A" and "B" proved to be statistically significantly ($P < 0.05$) different in all parameters measured from both the drum-drier processed sample and the home-cooked sample used as a reference, while the two latter had statistically ($P < 0.05$) equal values in all three physicochemical characteristics evaluated.

The difference observed in the maximum viscosity values obtained for the commercial samples in comparison with the drum-dried processed sample or the reference, is more easily appreciated in Figure 2, where the amylographic curves of the former are compared with the amylographic curve obtained for the double-drum drier processed sample. As noted, the curve obtained for the latter is very similar to that obtained for the reference (Fig. 1).

The organoleptic trials carried out by means of the triangle

*Table 1—Percent composition of reference, home-cooked corn dough[a] from white corn*

| Component | White corn dough |
|---|---|
| Moisture | 9.1 |
| Ether extract | 3.9 |
| Crude fiber | 1.3 |
| Protein (N X 6.25) | 10.6 |
| Ash | 1.5 |
| Nitrogen-free extract | 73.6 |
| Starch | 64.4 |
| Damaged starch | 57.1 (88.6)[c] |
| Total sugars[b] | 2.1 |
| Calcium (mg %) | 126.1 |
| Available lysine (g/16g N) | 2.5 |

[a] Freeze dried
[b] Expressed as glucose
[c] Figure in parentheses represents damaged starch as percent of total starch.

*Table 2—Some physicochemical characteristics of the reference home-cooked corn dough[a] from white corn*

| | White corn dough |
|---|---|
| Maximum viscosity (B.U.)[b] | 400 |
| Water absorption (ml %)[c] | 111 |
| Zeleny sedimentation value (ml) | 9 |

[a] Freeze dried
[b] Brabender units
[c] Measured in the farinograph at a standard tension of 300 B.U.

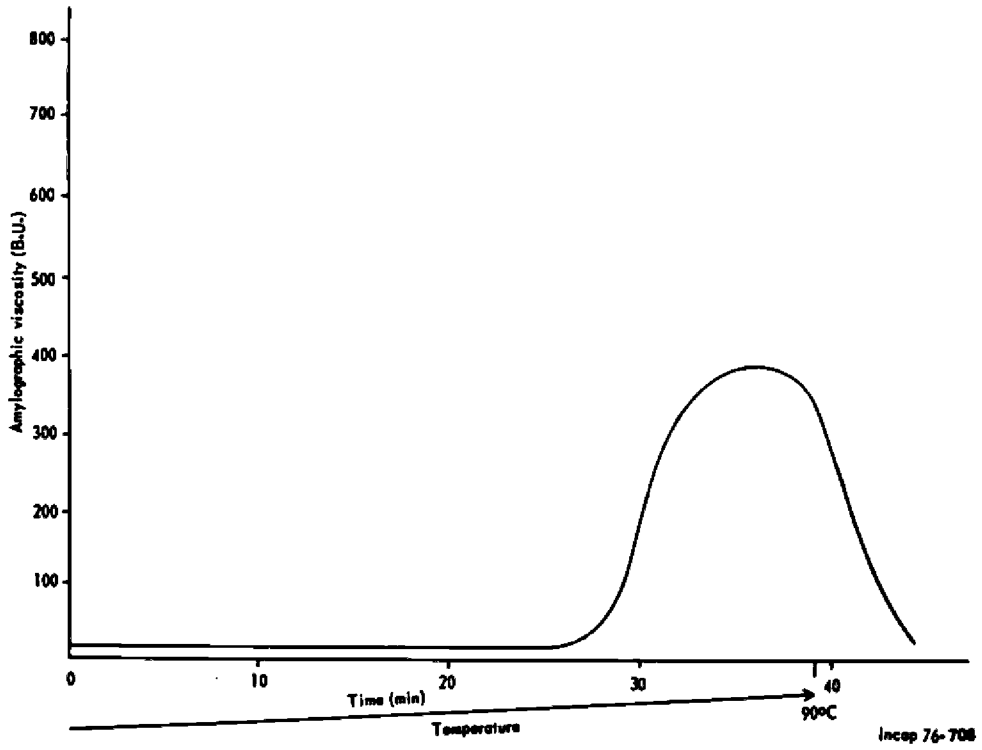


*Fig. 1—Amylographic curve obtained from the freeze-dried home-cooked corn dough from white corn.*

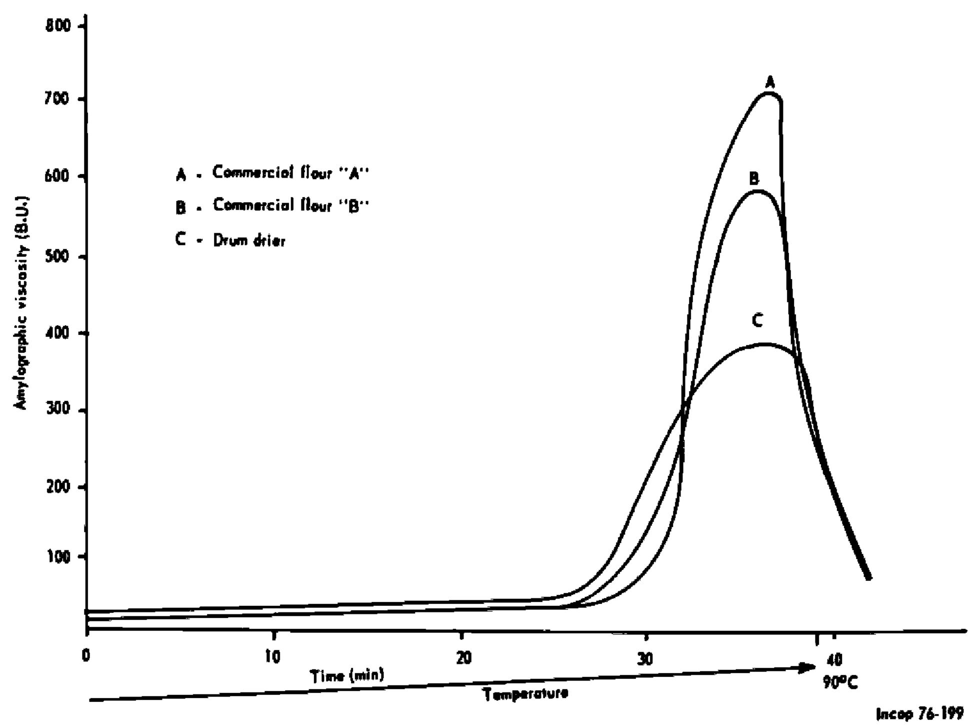


*Fig. 2—Amylographic curves obtained from commercial samples of instant tortilla flour and that obtained with the drum drier.*

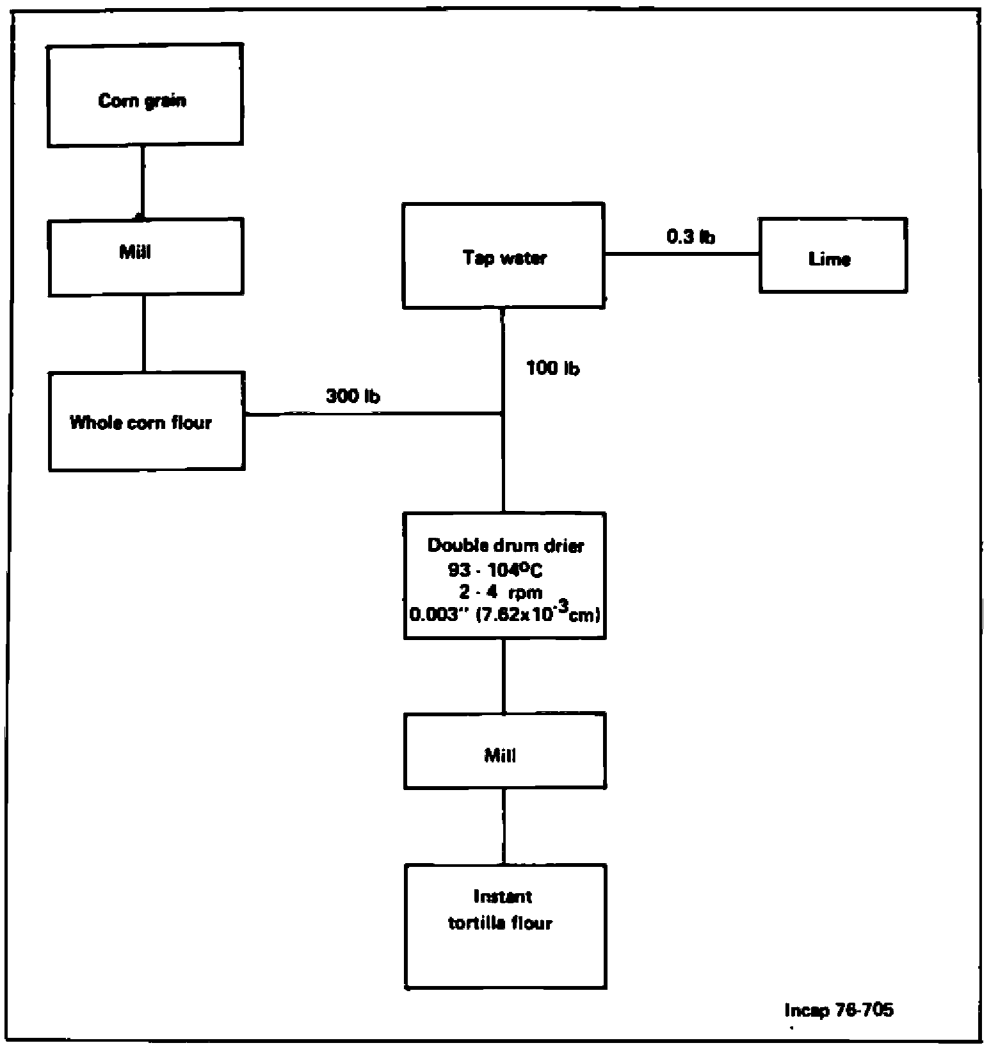


*Fig. 3—Flow diagram of the new process designed for the production of instant tortilla flour.*

method, revealed that while the instant tortilla flour obtained through the drum drier using either 15, 20 or 25 psig as internal pressure and 2, 3 or 4 rpm was statistically ($P < 0.05$) equal to the reference, the commercial samples "A" and "B" were statistically ($P < 0.05$) different.

Based on the above-mentioned findings, it is our contention that the commercial samples used in the present study were lacking the proper cooking conditions (time or temperature) as evidenced primarily by their significantly ($P < 0.05$) lower damaged starch content, maximum viscosity value and water absorption capacity (Tables 3 and 4). Their lower calcium content suggests a lower calcium absorption capacity. However, if a lower lime concentration is used in the production of such instant tortilla flours, this factor by itself can be affecting the physicochemical properties of the product by lowering the pH of the cooking water.

The process proposed herein for the preparation of instant tortilla flour from white common corn, is given in a flow diagram (Fig. 3). The production costs using this new process, with a drum drier velocity of 4 rpm and 25 psig as internal pressure (equivalent to 104°C surface temp) are $8.00 (U.S.) per 100 lb of instant tortilla flour based on a production rate of 3,200 lb/hr. The calculated production costs for the industrial process now in use—basically an adaptation of the home process—for a similar production rate, were $12.00 per 100 lb of product. The principal difference in cost is attributable to energy savings obtained through the new method.

Preliminary results indicate that this process can be successfully applied using an 85:15 corn:whole soybean mixture, obtaining a final product with higher protein quantity of good quality and greater caloric content. We consider that the cost of this or any other fortification technology considered for the tortilla (Molina et al., 1972) can be absorbed by the difference in production costs cited above. Thus, we can foresee the possibility of improving the nutritional quality of this basic staple of the Central American countries at no additional production cost through the implementation of technologies such as drum drying described herein.

*Table 3—Percent composition of commercial samples of instant tortilla flour and that obtained with the drum drier[a]*

| | Instant tortilla flour | | |
|---|---|---|---|
| Component | Commercial "A" | Commercial "B" | Drum drier |
| Moisture | 11.1 | 9.7 | 13.1 |
| Ether extract | 2.3 | 3.6 | 3.2 |
| Crude fiber | 1.5 | 2.1 | 1.4 |
| Protein (N X 6.25) | 9.2 | 9.7 | 10.8 |
| Ash | 1.3 | 1.5 | 1.4 |
| Nitrogen-free extract | 73.5 | 70.9 | 70.1 |
| Starch | 67.5 | 66.6 | 63.4 |
| Damaged starch | 47.6 (70.5)[c] | 51.4 (77.2) | 60.7 (95.7) |
| Total sugars[b] | 1.7 | 1.9 | 2.0 |
| Calcium (mg %) | 82.7 | 113.4 | 154.2 |
| Available lysine (g/16g N) | 3.1 | 2.8 | 3.1 |

[a] Processing conditions: 3 rpm, 20 psig internal pressure (99°C surface temp) and 100 ml of 0.3% lime suspension per 300g of whole common white corn flour.
[b] Expressed as glucose
[c] Figures in parentheses represent damaged starch as percent of total starch.

*Table 4—Some physicochemical characteristics of commercial samples of instant tortilla flour and that obtained with the drum drier*

| | Instant tortilla flour | | |
|---|---|---|---|
| Parameter measured | Commercial "A" | Commercial "B" | Drum drier[a] |
| Maximum viscosity (B.U.)[b] | 700 | 580 | 388 |
| Water absorption (ml %)[c] | 90 | 88 | 115 |
| Zeleny sedimentation value (ml) | 37 | 24 | 9 |

[a] Processing conditions: 3 rpm, 20 psig internal pressure (99°C surface temp) and 100 ml of 0.3% lime suspension per 300g of whole common white corn flour.
[b] Brabender units
[c] Measured in the farinograph at a standard tension of 300 B.U.

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