

POSSIBILITY OF INCORPORATING POTATO FLOUR INTO THREE TRADITIONAL KENYAN FOODS

Jackson N. KABIRA

National Potato Research Centre, Kenya

Jasper K. IMUNGI

*Department of Food Technology and Nutrition,
Faculty of Agriculture, University of Nairobi, Kenya*

ABSTRACT Potato flour was blended with commercial, sifted maize meal at 10, 20, 30 and 40% levels of substitution based on flour weight, and used to prepare *ugali* (stiff porridge) and *uji* (thin porridge). Also, potato flour equivalent to 30, 40 and 50% of fresh potatoes by weight was used in the preparation of *irio* (a mashed mixture of cooked whole maize grains, beans, potatoes and vegetables). Potato flour could be incorporated to replace up to 40% of the maize meal in *ugali* and *uji*, and up to 50% of the fresh potatoes in *irio*, without undesirable alteration in their physico-chemical and sensory characteristics.

Key Words: Potato flour; Traditional Kenyan foods.

INTRODUCTION

In Kenya, production of potatoes (*Solanum tuberosum*) has grown steadily during the last three decades. The potatoes are largely consumed fresh after boiling, frying, and following incorporation into various traditional dishes. Only a small portion of potatoes is processed.

Bulkiness makes fresh potatoes expensive to store, and the simple common storage methods used by small scale growers often lead to high post-harvest losses (Horton, 1987). Recently, however, it has been demonstrated that the raw potato in slice form can be dried and ground into flour, with good storage properties at tropical ambient temperatures (Kabira et al., 1990). In addition to extending the shelf life of potatoes and lowering storage costs due to reduced bulk, the potato flour could provide a convenient food item to replace fresh potatoes during times of scarcity.

The most commonly consumed traditional foods in Kenya are *irio*, a cooked mashed mixture of whole maize grains, beans, fresh potatoes and green vegetables; *ugali*, a stiff porridge, and *uji*, a thin porridge (Oi, 1980; Jansen et al., 1987). These foods, together with *githeri* (cooked mixture of maize and beans often stewed with potatoes and meat), place a lot of dependence on maize. Other cereals such as sorghum and millet, either wholly or partially, are occasionally used to replace maize in *ugali* and *uji* (Mbugua, 1977; Mukuru et al., 1982; Nout et al., 1988).

As a replacement for maize products in traditional foods, potato flour would

offer a good nutritional balance due to protein complementation with the cereals (Markakis, 1975). Although potato flour could be used in maize-based foods or as a replacement for fresh potatoes, no work has, however, been reported so far on its potential food uses in Kenya. This study was, therefore, conducted to investigate the possibility of incorporating potato flour into three traditional Kenyan foods.

MATERIALS AND METHODS

I. Potato Flour

Potato flour was produced from solar-dried slices according to a method outlined by Kabira et al.(1990) as follows: Peeling fresh potatoes, cutting into 1 mm slices, washing the slices, treating with sodium metabisulphite (five min in 0.5% solution) and spreading the slices in single layers on screen-bottom, galvanised wire mesh trays. The slices were then dried in a two-stage process for 20–24 hours, involving night-time exposure followed by direct solar drying, to a final moisture content of approximately 10%. The dried slices were thereafter hammer-milled to pass a 1.3 mm sieve.

II. Composite Flour

Regular sifted maize meal was obtained from a commercial flour mill (Unga Ltd.) in Nairobi. The maize meal was used to prepare flour blends containing 10, 20, 30 and 40% (flour weight basis) of potato flour. The flour blends were mixed in a manual flour mixer (Kamome homewasher, Hayasi mfg. Co. Ltd.) for five minutes. The blends were used to prepare *ugali* and *uji*.

III. Preparation of *Ugali*

Ugali was prepared by the method of Nyotu et al (1986). In this method, 150 g of flour was mixed thoroughly into 300 ml of boiling water and the paste cooked with occasional mixing for 20 minutes.

IV. Preparation of *Uji*

Approximately 150 g of flour was mixed with 75 g of sugar and the mixture stirred into 500 ml of cold tap water. The slurry was slowly added to 1.5 litres of boiling water and cooked with continuous stirring for 12 minutes.

V. Preparation of *Irio*

Irio was prepared with 30, 40, and 50% potato flour equivalents of fresh potatoes. A batch containing 40% fresh potatoes was prepared as a control. In the preparation, dry beans were mixed with dry maize grains in a ratio of 1:2 and

boiled in water for two hours (Anon., 1985). Approximately 10% chopped green pumpkin leaves and the potato flour were then added. The potato flour equivalents of fresh potatoes were calculated, based on preliminary trials, by assuming a four-fold increase in volume of the flour during cooking. Cooking was continued until the pumpkin leaves were tender, upon which the cooking water was drained. Approximately 2% salt was added and the mixture mashed with a wooden spoon to a firm consistency.

VI. Analytical Methods

The water absorption capacity of flour was determined by the centrifuge method of Sosulski (1962). Five grammes of flour samples weighed on a 14% moisture basis, were mixed with 40 ml of distilled water in centrifuge tubes and stirred periodically for 60 minutes. The suspension was centrifuged at 2,300 rpm for 25 minutes, the supernatant liquid decanted and the tubes drained and dried for 25 minutes at 50°C. After cooling in a desiccator, the tubes were weighed and percentage water absorption calculated as follows:

$$\% \text{ water absorption} = (X + Y - 5) \times 20$$

where X = increase in weight of the flour, in g;

Y = "as-is" weight of flour used, in g.

The water absorption capacity is a functional property of flour which can be used to predict potential usage in other foods. A very high absorption capacity would, for example, indicate potential textural problems for *ugali*, due to stickiness, and for *uji*, due to thinness.

Ugali hardness was measured with a fruit pressure tester (FT 011, Italy) as the force in kilogrammes required to push the penetrometer to a depth of approximately 5 cm. The consistency of *uji* was measured with a Bostwick Consistometer, following the procedure of Bookwalter et al (1968). The specific gravity of *uji* was determined using a calibrated 50 ml beaker, following the procedure of Osei-Yaw & Powers (1986). The pH of *uji* was determined with a Pye Unicam pH meter.

VII. Sensory Evaluation

Sensory evaluation of the foods for colour, texture, flavour and overall acceptability was carried out by untrained, in-house consumer panels (Watts et al., 1989). The products were evaluated on an ordinal scale of 1 to 8, whereby 1 represented extremely unacceptable; 2, very unacceptable; 3, moderately unacceptable; 4, slightly unacceptable; 5, slightly acceptable; 6, moderately acceptable; 7, very acceptable, and 8, extremely acceptable.

VIII. Statistical Analysis

Data were subjected to analysis of variance, and where significant differences were established at the 5% level of probability, the means were compared using appropriate tests (Larmond, 1977; Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Table 1 gives some physico-chemical properties of *ugali* and *uji* containing potato flour. Potato flour had no significant ($P > 0.05$) effect on the water absorption capacity of sifted maize meal nor the hardness of *ugali* and pH of *uji*. Potato flour, however, significantly ($P < 0.05$) increased the consistency and specific gravity of the *uji*. The higher consistency of *uji* following incorporation of potato flour suggests that potato flour can be used to prepare thinner *uji*, suitable for feeding small children (van Esterik & Elliott, 1986). The higher level of specific gravity in the *uji* containing potato flour is probably an indication of a good level of nutritional quality (Woolfe, 1987).

Table 2 shows the effect of potato flour on the sensory scores of *ugali*. In general, addition of potato flour significantly ($P < 0.05$) reduced most sensory parameters of the *ugali*. Whereas colour of *ugali* was acceptable (score > 5.0) at all levels of potato flour incorporation, texture was acceptable up to 20%; flavour up to 30%, and overall acceptability almost up to the 40% level.

The reduction in texture scores of *ugali* by addition of potato flour was probably due to an increase in the water absorption capacity and agrees with the reduction in *ugali* hardness readings given in Table 1. These observations suggest that potato flour could be used in preparation of softer *ugali* that would be more readily acceptable to small children and the elderly.

Table 3 shows the effect of potato flour on the sensory scores of *uji*. Only slight differences were found in the colour, texture, flavour and overall acceptability of the samples. It would seem, therefore, that incorporation of potato flour into maize meal up to the level of 40% does not affect the sensory quality of *uji* to any appreciable extent. Furthermore, potato flour would probably be suitable for household preparation of fermented cereal-based *uji*, commonly used in Kenya and other East African countries (Nout et al., 1988), due to the outstanding ability of potato constituents to stimulate fermentation of sugar as has been reported by Willard (1975).

Table 4 shows the sensory scores of *irio* prepared with potato flour equivalents of fresh potatoes. Use of potato flour significantly ($P < 0.05$) reduced the sensory scores of regular *irio*. However, all the samples were acceptable up to the 50% replacement level for fresh potatoes. Although the common level of fresh potatoes

Table 1. Some physico-chemical properties* of sifted maize meal foods, *ugali* and *uji*, containing different levels of potato flour.

Level of potato flour by weight (%)	Flour water absorption capacity (%)	Ugali hardness (kg)	Uji		
			Consistency (cm/min)	Specific gravity	pH
0	149.6	1.5	9.2a	1.085a	5.7
10	154.6	1.2	10.4b	1.091b	5.8
20	154.8	1.2	11.8c	1.091b	5.8
30	159.1	1.1	11.9c	1.112c	5.9
40	160.2	1.1	12.3c	1.138c	5.8

*, Means ($n=3$) within columns followed by similar letters or without letters showed no significant differences at $P=0.05$ by the LSD test.

Table 2. Effect of potato flour on the sensory scores* of *ugali*.

Level of potato flour by weight (%)	Colour	Texture	Flavour	Overall acceptability
0	7.0a	6.7a	6.8a	6.8a
10	6.3b	6.0a	5.9bc	6.2ab
20	5.8b	5.3ab	5.4b	5.5ab
30	5.1bc	4.7bc	5.2b	5.1b
40	5.0bc	4.1bc	4.7bcd	4.9b

*, On an ordinal scale of 1 to 8, where 1=extremely unacceptable and 8=extremely acceptable (n=31).

Means within columns followed by similar letters showed no significant differences at P=0.05 by Tukey's test.

Table 3. Effect of potato flour on the sensory scores* of *uji*.

Level of potato flour by weight (%)	Colour	Texture	Flavour	Overall acceptability
0	6.6	6.5	6.4	6.7
10	6.6	6.4	6.3	6.7
20	6.4	6.5	6.3	6.6
30	6.2	6.3	6.0	6.3
40	6.1	6.4	6.1	6.3

*, On an ordinal scale of 1 to 8, where 1=extremely unacceptable and 8=extremely acceptable (n=21).

Table 4. Sensory scores* of *irio* prepared with potato flour equivalent of fresh potatoes.

Level of potato flour by weight** (%)	Colour	Texture	Flavour	Overall acceptability
0 ⁺	6.8a	6.8a	6.5a	6.7a
30	6.1ab	5.6b	5.8b	5.9b
40	6.1bc	5.9b	5.9b	6.1b
50	5.5c	5.5b	5.4b	5.7b

*, On an ordinal scale of 1 to 8, where 1=extremely unacceptable and 8=extremely acceptable (n=54).

Means within columns followed by similar letters showed no significant differences at P=0.05 by Tukey's test.

⁺Control, 40% (w/w) of fresh potatoes.

******, The level of potato flour was on a weight-by-weight basis expressed as a percentage of the total *irio* mix.

in *irio* is approximately 30–40% (Durr and Lorenzl, 1980), the results of this study indicate that even *irio* with up to 50% potato would be acceptable to consumers. The usual level of up to 40% is probably a compromise between optimal sensory quality and cost of ingredients.

In conclusion, this study has shown that potato flour can be incorporated successfully into traditional maize-based African foods in Kenya without sacrificing consumer acceptability. The potato flour could also be used to replace fresh potatoes, an aspect which has special nutritional and food security significance since potato flour is a product with longer shelf life than fresh potatoes. Use of

potato flour in traditional foods would ease pressure on the demand for both fresh potatoes and cereals by the rapidly increasing number of consumers in Kenya and other African countries, where potatoes are grown abundantly.

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REFERENCES

- Anon 1985. *Technical Compendium on Composite Flour-Technologies Available for Application*. United Nations Economic Commission for Africa, Addis Ababa, Ethiopia.
- Akpanunam, M. A. & P. Markakis 1981. Physicochemical and nutritional aspects of cowpea flour. *Journal of Food Science*, 46: 972-973.
- Bookwalter, G. N., A. J. Peplinski & V. J. Pfeifer 1968. Using a Bostwick Consistometer to measure consistencies of processed corn meals and their CSM blends. *Cereal Science Today*, 13: 407-410.
- Durr, G. & G. Lorenzl 1980. *Potato Production and Utilization in Kenya*, pp.85-113, International Potato Centre, Lima-Peru.
- Esterik, P. Van & T. Elliott 1986. Infant feeding style in Kenya. *Ecology of Food and Nutrition*, 18: 183-195.
- Horton, D. E. 1987. *Potatoes: Production, Marketing and Programs for Developing Countries*, pp.207-219, Westview Press, Inc., Boulder, Colorado.
- Jansen, A. A. J., H. T. Horelli & V. J. Quinn 1987. *Food and Nutrition in Kenya: A Historical Review*, pp. 23-87, Department of Community Health, Faculty of Medicine, University of Nairobi, Nairobi, Kenya.
- Kabira, J. N., J. K. Imungi, J. Haas & R. Amado 1990. Proximate composition, mineral contents and protein nutritional quality of potato (*Solanum tuberosum*) flour from solar-dried raw potato slices. A paper presented at the Joint Workshop on the Production, Postharvest Technology and Utilization of Potato in the Warm Tropics and 2nd Triennial Meeting and Conference of the African Potato Association, Reduit, Mauritius, July 23-27, 1990.
- Larmond, E. 1977. *Laboratory Methods for Sensory Evaluation of Food*. Research Branch, Canada Department of Agriculture Publication No. 1639, pp.41-46, Ottawa, Canada.
- Markakis, P. 1975. The nutritive quality of potato protein. In (Friedman, M. ed.) *Protein Nutritional Quality of Foods and Feeds*. Marcel Dekker, New York.
- Mbugua, S. K. 1977. The survey on the recipes for *uji*, the extent and mode of its consumption in the Kenya urban areas. Department of Food Science and Technology, University of Nairobi, Nairobi, Kenya.
- Mukuru, S. Z., J. N. Mushonga & D. S. Murty 1982. *Sorghum ugali*. In Proceedings of the International Symposium on Sorghum Grain Quality, October 28-31, 1982, Patancheru, A. P., India.
- Nout, M. J. R., J. G. A. J. Hautvast, F. Van der Haar, W. E. W. Marks & F. M. Rombouts 1988. Formulation and microbiological safety of cereal-based weaning foods. In (D. Alnwick, S. Moses & O. G. Schmidt, eds.) *Improving Young Child Feeding in Eastern*

- and Southern Africa, International Development Research Centre, Ottawa, Canada.
- Oi, Y. 1980. Nutrition in Kikuyuland, Kenya: Intake frequency and preference to staple foods (principal dishes). Translation from Heian Jogakuin Tanki Daigaku Kigo (Memoirs of the Saint Agnes Junior College), No. 11.
- Nyotu, H. G., I. Alli & G. Paquette 1986. Soy supplementation of a maize based Kenyan food (*ugali*). *Journal of Food Science*, 51: 1204–1207.
- Osei-Yaw, A. & J. R. Powers 1986. Batter properties of yellow pea flour with respect to *Akla* preparation. *Cereal Chemistry*, 63: 506–511.
- Sosulski, F. W. 1962. The centrifuge method for determining flour absorption in hard red spring wheats. *Cereal Chemistry*, 39: 344–350.
- Steel, R. G. & J. H. Torrie 1980. *Principles and Procedures of Statistics*, (2nd ed.). McGraw-Hill Book Co., New York.
- Watts, B. M., G. L. Ylimaki, L. E. Jeffery & L. G. Elias 1989. *Basic Sensory Methods for Food Evaluation*. International Development Research Centre, Ottawa, Canada.
- Willard, M. 1975. Potato flour. In (W. F. Talburt & O. Smith, eds.) *Potato processing*, pp. 563–578, The Avi Publication Company, Inc., Westport, Connecticut.
- Woolfe, J. A. 1987. *The Potato in the Human Diet*. Cambridge University Press, Cambridge, U. K.

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Authors' Names and Addresses: Jackson N. KABIRA, *National Potato Research Centre, P. O. Box 338, Limuru, Kenya*; Jasper K. IMUNGI, *Department of Food Technology and Nutrition, Faculty of Agriculture, University of Nairobi, P. O. Box 29053, Kabete, Kenya*.