Selecting maize varieties for eating quality in East Timor

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Abstract

Maize is the staple cereal crop in East Timor, with 90% of farmers growing it for human consumption. This paper compares local low-yielding corn varieties and modern high-yielding varieties in terms of processing, cooking and taste attributes.

Maize preparation is a time-consuming process for Timorese women. The grain is first mixed with a little water, and pounded in a wooden vessel using a long wooden pole. It is then cleaned by removing the fine material, which is fed to animals. The resulting corn grit is then boiled with beans and green leaves for approximately 1.5 hours before being eaten.

Three different communities were asked to process, cook and taste-test 3 kg each of two populations of corn, namely a local white corn (locally named *kakatua*) and Arjuna, a modern variety. For each group, Arjuna produced a higher percent of fine material when pounded, took 60 to 100% longer to pound, and tasted very similar when finally cooked.

In addition, 3 local maizes and 14 recent maize introductions were evaluated in the laboratory for grain shape and size, resistance to crushing, and percent fines when pounded. The testing showed that the 3 local populations tested were easier to crush and produced significantly less fines than the introduced populations. This could partly explain the low adoption rates for new varieties, despite their higher yields.

As a result of this study it is recommended that in conjunction with field testing of new maize varieties, they be tested in the laboratory and with the community for processing, cooking and eating quality.

Media summary

Less than 15% of East Timorese farmers plant modern maize varieties, despite their much greater yields. What is wrong with the new varieties?

Key Words

flint, breeding, grain-quality

Introduction

Increasing the maize production of subsistence farmers in East Timor is a critical but elusive goal. Currently there is an annual cereal feed gap of 3-6 months. During this 'hungry season', the rural population rely on root crops and wild plants for food and nutrition.

Increasing maize yields by the use of modern high-yielding varieties is a sustainable and cost-effective way to increase on-farm maize yields and reduce the length of the hungry season. Two modern high-yielding maize varieties, Arjuna and Kalinga, were bred in Eastern Indonesia and released in 1980 and 1985 respectively. During the Indonesian period, the East Timorese provincial agricultural extension service (as it was then) attempted to extend the use of these new varieties. However, adoption has been very low, even though they produce a 50-200 % yield increase in research trials.

Since the emergency period after the violence of September 1999, NGO's have continued to distribute seed of Arjuna and Kalinga in an attempt to re-supply seed stocks and improve the genetic base of the maize used in East Timor. However, after 2-3 seasons, the utilisation of these modern high-yielding varieties has remained very low.

Anecdotally, there are many reasons for the poor adoption of these modern high-yielding varieties. These include poorer processing and cooking quality, less resistance to insect attack during storage, poor seed quality when stored seed is planted next season, and tasting ‘bitter’.

This project reports an investigation into one aspect of the difference between local maize and modern higher-yielding varieties. In particular, its aim was to determine the quality attributes of maize that East Timorese farmers like to cook and eat. A further objective was to determine whether laboratory tests could be used to predict the performance of maize varieties when pounded in preparation for cooking.

Methods

Taste-testing with local farmer groups

Two different maizes were presented to 3 different communities for processing and taste-testing. The 2 maize types used were Aileu Local, purchased in the market at Aileu, and Arjuna M, purchased from farmers in Maliana who had grown it that year from certified Arjuna seed.

The taste tests were conducted with three extended families who regularly cook and eat maize. Each group was given 3 kilograms each of Aileu Local and Arjuna M. Each variety was processed separately, being pounded in separate vessels, washed and cleaned, then boiled for approximately 1.5 to 2 hours. At each location, the resultant porridge was tasted by more than 20 individuals of mixed age and gender. Between them, the testers originated from 4 of the 13 districts of East Timor, namely Dili, Baucau, Maliana and Aileu.

Laboratory measurements

Laboratory testing was conducted on 17 open-pollinated maize populations (Ceniceros et. al. 2003). These consisted of 3 local maizes, 2 sources of the modern variety Arjuna, and 12 recent introductions grown during the previous season as part of the Seeds of Life project in Timor (Piggin and Palmer 2003).

With regard to maize source, Aileu Local and Maliana Local were purchased from markets in Aileu and Maliana respectively. Aileu Local 2 was grown as a local check in the Seeds of Life variety evaluation. As noted above, Arjuna M was purchased from growers in Maliana who had grown the seed that year from certified Arjuna seed. Arjuna A was sourced from the Seeds of Life evaluation trial, as were the recent introductions M1 to M12.

Seed length, width and height were measured for 50 individual seeds for each population using a vernier scale calliper. Roundness was calculated as per Eqn 1.

Eqn 1 Roundness = $(\text{Length-Width})^2 + (\text{Length-Height})^2 + (\text{Height-Width})^2$

For each variety, the force required to crush an individual grain was measured on three replicates of 20 seeds each. To reduce the crushing force required, the seeds were first dried overnight at 80^{o}C. The crushing force was measured with a soil penetrometer, with a maximum load of 40kg, and a 0.6 cm^2 tip. A preliminary experiment had demonstrated that a 0.6 cm^2 tip was superior to a 0.3 or 1.2 cm^2 tip for distinguishing populations.

To measure the percent fine material produced by each population when pounded, a 50 g sample was pounded in a traditional wooden vessel with a wooden pole for 5 minutes. The broken grains were removed from the vessel, and fine material was separated from the grit using traditional winnowing techniques. The grit and the fine material were dried overnight at 80^{o}C, and then weighed. From this, the percent of fines was calculated.

Results

Taste-testing with local farmer groups

In this test, the modern maize variety Arjuna took 60-100% longer to pound than the local variety. This was confirmed in the laboratory, where the force required to shatter Arjuna seed was 45% higher than that required to shatter the local maize.

Testers also found that Arjuna produced a higher percentage of fines when pounded. In the taste teste, Arjuna was judged to be slightly 'sweeter', that is, more tasty, than the Aileu Local maize.

Table 1. Results of test-tasting using Arjuna M and Aileu Local

Character	Arjuna M	Aileu Local
Pounding	Difficult to pound (60-100% longer)	Easy to pound
Percent fines	High	Low
Texture when cooked	Similar	Similar
Taste	A little 'sweeter' (more tasty)	Normal
Cooking time	1.5-2 hours	1.5-2 hours

Laboratory measurements

Laboratory testing showed clear differences between the 3 local lines and the 14 introduced lines in terms of shape, the force required to crush the grain, and the percentage of fine material produced when the grain is pounded (Table 2).

Table 2. Laboratory characteristics, source and shape of the 17 maize populations evaluated.

Description	Source	Type	Length (mm)	Width (mm)	Depth (mm)	Round-ness	Force to crush (kg)	Fines when pounded (%)
Aileu Local	Aileu market	Local	7.5	7.0	4.5	20	21	29.1
Maliana Local	Maliana market	Local	8.3	8.3	4.5	32	20	31.1
Aileu Local 2	Seeds of Life	Local	9.8	8.2	4.4	51	19	37.1

Arjuna M	Maliana	Modern	10.3	8.8	4.4	61	29	36.6
Arjuna A	Seeds of Life	Modern	9.6	7.7	4.4	46	27	44.7
M1	Seeds of Life	Modern	10.6	8.5	4.4	67	27	49.1
M2	Seeds of Life	Modern	11.7	8.4	4.3	90	23	44.0
M3	Seeds of Life	Modern	11.2	9.3	4.1	85	25	42.7
M4	Seeds of Life	Modern	11.4	8.5	3.9	89	24	44.4
M5	Seeds of Life	Modern	11.2	8.8	4.2	80	24	43.3
M6	Seeds of Life	Modern	11.0	9.1	4.5	73	27	37.3
M7	Seeds of Life	Modern	11.8	9.2	4.4	73	25	40.8
M8	Seeds of Life	Modern	10.4	8.8	4.6	61	26	44.0
M9	Seeds of Life	Modern	11.2	9.1	4.4	80	28	44.4
M10	Seeds of Life	Modern	11.6	9.2	4.4	86	29	46.7
M11	Seeds of Life	Modern	10.5	8.8	4.6	60	28	41.3
M12	Seeds of Life	Modern	9.6	8.2	4.4	48	24	37.4

LSD (p<0.05)	2.2	2.2	1.4	15	2.4	8.6

Two of the local lines (Aileu Local and Maliana Local) were significantly shorter and rounder than the modern variety Arjuna and most of the introduced lines (Table 2). The third local line was intermediate between these two local lines and the 14 introduced lines for length and width. The three local lines of maize required significantly less force (20 kg) to crush the grain than almost all the modern and introduced populations (26 kg).

Overall similarity between the 17 maize populations was calculated based on grain length, thickness, crushing force and percent fines when pounded. The resulting dendogram is shown in Figure 1.

The three local lines form a group on the right hand side of the dendogram, quite distinct from the 14 introduced lines. The two sources of Arjuna used in this trial appear quite close together in the centre of the dendogram.

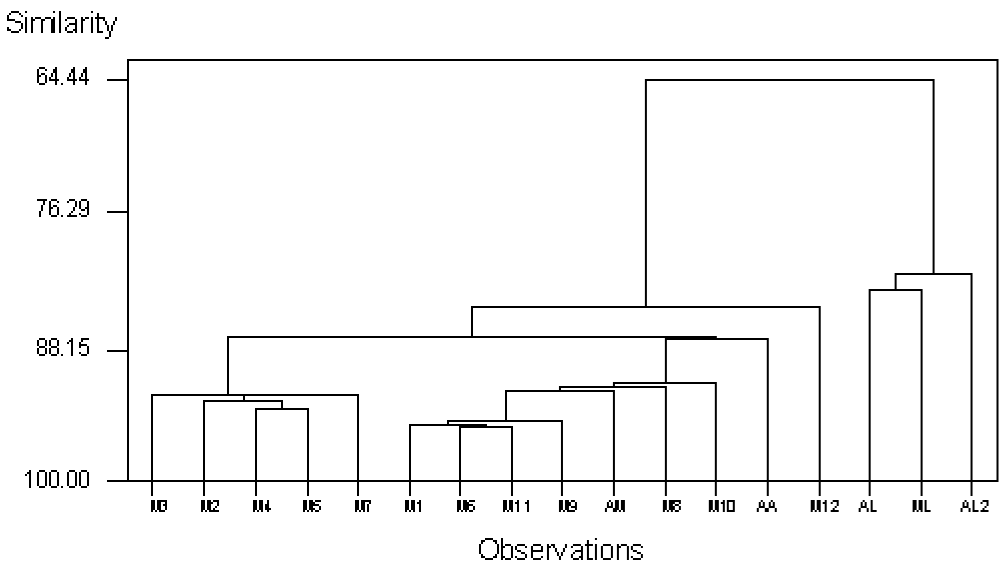

Figure 1. Dendogram of similarity of 12 recently introduced lines (M1-12), 2 sources of Arjuna (AM and AA) and 3 local populations (AL, ML and AL2)

Conclusion

The 14 introduced maize populations were shown to be different to the 3 local populations tested in terms of size, shape and processing characteristics. This is consistent with the local maizes being of the flint type, and the introduced lines being semi-flint or dent populations. The characteristics of flint maize include a rounded crown, small embryo and mostly hard flint starch (Dowswell et. al. 1996: 17–34). Timorese maize growers also recognise that flint corn is more weevil resistant than the introduced lines; such weevil resistance can be due to greater kernel hardness (Bergvonson 2001). In light of this expected hardness, it proved very surprising that the local flint quality maize is in fact easier to pound, and has a lower crushing force than the introduced semi-flint maizes.

It is recommended that in conjunction with field testing of new maize varieties, they be tested in the laboratory and with the community for processing, cooking and eating quality. It is further recommended that true flint quality maize populations with a high yield potential be introduced to East Timor for variety evaluation.

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