Development of Quality Protein Maize (QPM) in Indonesia

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Abstract: The development of white QPM in Indonesia is aimed to increase the quality of food nutrition especially in the eastern part of Indonesia such as NTT (Timor Island, Flores, Sumba), NTB (East and West Lombok), South Sulawesi, and Northern part of Maluku, while the yellow QPM is used for feed. Two QPM synthetic populations (S98TLWQ. F/D and S99TLYQ-AB) were released in 2004 as the first national QPM varieties "Srikandi putih-1" (white kernels) and "Srikandi kuning-1" (yellow kernels). Two sets of experiments (22 populations of yellow QPM and 10 populations of white QPM, respectively) were compared with the normal check varieties. Each set used a randomized complete block (RCB) design with three replications in 11 locations of central maize areas in Indonesia during 2002 ~ 2003. The stability model shown that genotype x environment interaction was significant for grain yield. The potential grain yield Srikandi putih-1 was 7. 91 t/ha or 13. 4% greater than the best normal maize (MS-2). Grain yield of Srikandi kuning-1 was 7. 92 t/ha or 2. 0% greater than normal maize check variety Bisma. The white and yellow QPM varieties possessed lysine concentration of 0. 36%, and 0. 459% and tryptophan concentration of 0. 071 % and 0. 085%, respectively.

Key words: QPM, Development, Lysine, Tryptophan, Lndonesia

Introduction

Maize in Indonesia is second in importance as a staple food after rice, but in some areas like in the eastern part (NTT, NTB, and Maluku), maize is the main food for the local/indigenous farmers. In 2002 ~ 2003, the area under maize was around 3. 4 ~ 3. 8 million ha in the dryland (tegaland) and wetland (sawah) after rice with potential yield of 2. 0 ~ 2. 1 t/ha (CBS, 2003). In Indonesia, there are 29 open-pollinated varieties (OPVs) released as national varieties until 2003 ~ 2004; all these materials were normal non-QPM maize (ICERI, 2002). QPM varieties "Srikandi putih-1" (putih: white kernel) and "Srikandi kuning-1" (kuning: yellow kernel) were released in June 2004 by Indonesian Ministry of Agriculture as the first national variety. The two varieties were based on CIMMYT synthetic populations S98TLWQ(F/D) and S99TLYQ-AB.

Indonesia was a new country as far as QPM varietal release is concerned. Countries like Ghana have successfully released QPM varieties like Obatanpa (*good mother*) in 1992, and nearly 50% (100 000 ha) of the area in the country is currently planted to this variety (Cordova and Pandey, 2002; Prasanna *et al.*, 2001). In different countries (Argentina, Bolivia, Brazil, China, Mexico) QPM OPVs and hybrids have been released (Vasal, 2000).

Performance of QPM Srikandi putih-1 and Srikandi kuning-1

Srikandi putih-1 and Srikandi kuning-1 have been evaluated with some QPM materials introduced from CIMMYT under several locations in central Indonesia. The evaluation variety trial (evt) was conducted in the rainy seasons 2002 ~ 2004 with two sets (white and yellow materials). Several populations, including 10 white QPM and 22 yellow QPM were evaluated along with three white and two yellow ICERI OPVs as normal maize checks. The entries were arranged in a randomized block design with three replications. Each entry was grown in a four-row plot with 5 m length, 75 cm apart and 25 cm within-row spacing and one plant per

hill. ANOVA was carried out on the data from each location as well as on pooled data to evaluate interaction with entries (E × L) (Table 1) as per methods suggested by Singh and Chaudhary (1985) and Einsensmith (1988). Stability statistics were used to compare Srikandi putih-1 and Srikandi kuning-1 with the normal maize checks (white: MS-2 or Tuxpeno sequia C6, Bayu, and Pulut; yellow: Bisma and Lamuru). The results showed that there was a highly significant interaction of entries with the locations (Table 1).

Table 1 **ANOVA of white and yellow QPM varieties**

	White materials	Yellow materials
Location (L)	75.964**	162.381**
Replication/L	0.370	3.239
Entries (E)	2.532**	2.111**
Interaction (L × E)	1.228**	0.744**
Error	0.342	0.453
CV (%)	11.91	14.94

** Significant at 1% level

The average potential yields of Srikandi putih-1 and Srikandi kuning-1 under 11 locations were 4.92 t/ha and 4.81 t/ha, respectively (Table 2 and Table 3). The highest check normal maize for white MS-2 yielded 4.34 t/ha and yellow Lamuru was 4.72 t/ha. Srikandi putih-1 recorded 13.4% higher yield than the normal maize, and Srikandi kuning-1 was 2.0% higher yielding than the checks. The concentration of lysine and tryptophan in Srikandi putih-1 were 0.360% and 0.071%, respectively, which were 39.5% and 26.7% higher than MS-2 normal maize, respectively. Srikandi kuning-1 recorded 0.456% and 0.085% lysine and tryptophan, which were 64.71% and 60.0% higher than the normal maize Bisma. Pixley and Bjarnason (1993) and Bjarnason *et al.* (2002) showed that the percent tryptophan in the endosperm of QPM was 2 ~ 3 fold higher than the normal, and simultaneous improvement of both protein quality and grain yield was possible.

Table 2 **Grain yield (in t/ha) of the white QPM variety under EVT in Central Indonesia**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
QPM white												
1. Srikandi putih-1 (S99TLWQ(F/D)	6.11	3.31	5.71	6.59	4.29	3.67	7.91	2.61	6.35	3.67	3.98	4.92
2. S99TLWQ-B	5.68	3.68	5.49	7.11	3.89	3.24	6.84	2.41	6.69	2.85	3.59	4.67
3. S99TLWQ-AB	6.31	3.66	4.91	6.78	3.64	4.28	7.25	4.16	6.43	3.25	2.99	4.67
4. S00TLWQ-B	6.07	3.30	5.42	6.12	3.58	3.16	5.57	2.35	5.81	4.40	2.86	4.42
5. S00TLWQ-AB	4.95	3.24	5.29	7.40	3.68	3.71	7.29	3.46	5.47	2.80	3.56	4.62
6. Obatampa (Across 8363)	6.29	3.58	4.77	7.22	4.07	3.71	3.60	3.03	5.16	3.25	2.45	4.28
7. Poza Rica 8563	5.98	3.43	5.34	7.54	3.80	3.48	7.06	4.73	7.24	4.03	2.38	5.00
8. Across 8763	6.26	3.30	5.71	5.54	4.42	3.70	7.01	2.89	7.02	3.35	2.31	4.68
9. Pop. 62C6TLWQ	3.45	5.24	5.13	6.65	3.23	2.71	6.96	3.47	6.83	4.17	3.22	4.64
10. Pop. 63C2TLWQ	4.35	5.59	5.92	7.33	4.23	2.67	7.77	4.36	6.74	3.58	3.96	5.13
11. MS-2 (Tux. Seq. C7)	4.34	2.75	4.67	5.84	4.11	3.45	6.60	4.06	5.38	3.23	3.31	4.34
12. Bayu	4.16	2.60	—	—	—	—	6.74	3.33	4.48	3.23	1.26	3.68
13. Pulut	2.01	2.60	3.49	2.38	3.72	1.39	—	—	—	—	1.74	2.47
CV (%)	16.4	14.1	10.25	9.05	13.43	11.95	15.4	16.7	9.12	20.6	28.5	—
LSD 5%	1.45	0.77	0.89	1.2	0.76	1.02	1.7	0.90	0.90	1.2	1.47	—

EVT locations in 2004: (1) Muneng, (2) Jeneponto, (3) Blora, (4) East Lombok, (5) Bukittinggi, (6) Kambang. EVT locations in 2003: (7) Ba jeng, (8) Gorontalo, (9) Muneng, (10) Banjarbaru, (11) Maumere. Entries no. 11, 12, and 13 are normal maize checks

Development of QPM in Indonesia

To promote QPM in Indonesia, we have to enhance the linkages among the extension workers, NGOs and ICERI. In general, demand for maize has been increasing due to the rapid growth of demand for livestock feed and food industry. QPM varieties like Srikandi pu-

tih-1 and Srikandi kuning-1 would enhance the utilization of maize in the food, feed and industrial sectors. QPM can also play vital role in improving the quality of food, particularly for the babies and indigenous farmers in the eastern part of Indonesia, like NTT (Timor island, Flores island, and Sumba), NTB (West and East Lombok), Southern part of Sumawesi, and Maluku. In the last few months there have been several incidences of kwashiorkor (*busung lapar*) in children. QPM is an important avenue for enhancing the nutritional security.

At present, after the release of Srikandi putih-1 and Srikandi kuning-1, production of 2 157 kg seeds was carried out by the Institute for conducting as plot demonstrations and for multiplication by seeds grower. Training on QPM seed identification on light table was given to the extension personnel and researchers, so that they can score QPM modifiers (1 ~ 5, 1: indicating that kernels are completely vitreous, to 5: completely soft). Pixley and Bjarnason (1994) clearly showed that superior protein quality of QPM is only expressed in kernels homozygous for the recessive *opaque-2* allele, and contamination by pollen from normal maize will reduce nutritional value of affected QPM grain. The central government of Aceh Province (Tsunami accident on December 2004) received 900 kg seeds Srikandi putih-1 and Srikandi kuning-1 free for distribution to the farmers; these seeds were planted in about 45 ha in one district.

Table 3 **Grain yield (in t/ha) of yellow QPM under EVT in Central Indonesia**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
QPM yellow												
1. Srikandi kuning-1 (S99TLYQ-AB)	5.34	3.29	5.81	4.43	4.46	5.82	7.92	6.25	0.72	3.33	4.04	4.81
2. S99TLYQGH"A"	5.54	3.28	6.41	4.41	4.07	4.39	7.15	6.19	0.80	2.76	4.14	4.46
3. S99TLYQGH"AB"	4.27	2.75	5.05	4.14	4.27	4.09	7.29	4.57	1.35	2.53	3.93	4.01
4. S99TLYQ-A	5.25	2.92	5.58	4.43	3.97	4.56	7.82	4.92	1.31	2.04	3.15	4.13
5. S00TLYQ-B	5.24	2.84	5.73	3.98	3.78	4.39	6.38	5.04	1.40	2.00	2.46	3.94
6. S00TLYQ-AB	4.96	2.85	5.01	4.14	4.43	4.48	7.89	5.29	1.04	2.36	3.75	4.19
7. ACROSS 8365	5.66	3.57	5.54	4.10	4.65	4.41	6.90	5.82	1.38	1.51	4.11	4.33
8. POZA RICA 8365	5.00	2.46	4.97	4.34	5.75	4.67	7.82	5.07	1.32	2.38	3.81	4.30
9. IBOPERENDRA 8565	6.25	2.44	4.11	4.26	3.98	4.23	7.37	5.40	0.68	2.58	3.43	4.10
10. ACROSS 8565	5.00	3.75	5.54	4.36	3.92	4.26	7.91	5.62	0.97	2.39	4.26	4.36
11. TOCUMEN 8565	5.66	3.44	6.02	4.10	4.04	4.18	7.81	5.03	1.18	2.41	3.61	4.32
12. TOMEGUIN 8565	4.29	3.05	5.11	3.79	4.28	4.90	7.35	5.69	1.10	2.38	4.49	4.15
13. POZA RICA 8765	5.86	3.50	6.07	4.19	4.51	4.80	7.10	5.58	1.25	2.92	3.94	4.52
14. ACROSS 8765	4.41	2.83	4.09	3.95	4.55	4.11	7.34	5.87	1.03	2.47	3.99	4.05
15. GUIANIA 8765	4.57	2.80	5.14	4.18	3.67	4.19	7.86	5.75	1.11	2.27	3.91	4.13
16. IBOPERENDA 8666	5.08	2.90	5.42	4.44	4.51	4.12	7.36	5.89	0.99	2.48	4.11	4.12
17. ACROSS 8666	5.18	3.86	6.56	3.86	4.33	4.29	8.13	6.25	1.33	1.89	4.12	4.52
18. POZA RICA 8666	5.08	2.38	4.56	4.12	4.18	4.30	7.44	5.91	1.16	2.28	4.01	4.12
19. S89TLYQ(F/D)	5.01	2.95	4.34	3.94	4.89	3.50	6.70	4.78	1.48	3.03	3.68	4.02
20. Pop. 61C1QPM. TEYF	2.94	2.27	3.10	4.74	4.43	5.42	7.51	5.18	1.11	2.19	3.41	3.84
21. S87P69Q	3.08	2.17	3.63	4.22	4.84	5.36	6.92	4.67	1.90	1.60	3.42	3.98
22. S87P65Q	3.70	1.93	2.23	4.48	4.27	4.36	7.03	4.94	1.40	2.37	3.78	3.68
23. Bisma	5.53	3.39	4.09	4.72	5.28	4.18	8.86	5.82	1.30	2.90	5.92	4.72
24. Lamuru	6.24	2.76	3.27	4.74	4.21	4.17	7.90	7.03	1.36	2.83	5.06	4.50
CV (%)	13.7	16.92	20.27	7.9	15.8	14.9	10.16	15.5	23.7	12.70	17.1	—
LSD 5%	1.1	0.81	1.63	0.55	1.14	1.12	1.24	1.30	0.90	1.33	1.37	—

EVT locations in 2004: (1) Bajeng, (2) Jeneponto, (3) Malang; EVT locations in 2003: (4) Bontobili, (5) East- Lombok, (6) West Lombok, (7) Sukabumi, (8) West Java, (9) Timur Tengah Selatan, (10) Maumere, (11) Natar. Entries no. 23 and 24 are normal maize checks

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