

Genetic Diversity Studies on Selected Rice (*Oryza Sativa*) Genotypes Based on Amylose Content and Gelatinization Temperature

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Abstract

Oryza sativa

of 0.4697. Pair-wise genetic dissimilarity coefficients ranged from 0.9003 to 0.2251 with an average of 0.5627. *ITA 310, Saro 5* *R 2794* *R 2793* *BS 17, Supa* *IR 64, R 2793* *ITA 310, Saro 5* *Wahiwahi* *BW 196, IR 64* *BW 196*.

Keywords: *Oryza sativa*; *Oryza glaberrima*; Heterozygosity; Germplasm; Genotypes

Introduction

Rice (*Oryza spices*) is a monocotyledonous plant belonging to the family Gramineae and subfamily Oryzoidea. It is cultivated under diverse eco-geographical conditions in various tropical and subtropical countries [1]. Due to its importance as a food crop, rice is being planted on approximately 11% of the Earth's cultivated land area [2]. It is the grain with the third highest production globally after sugarcane and maize (FAOSTAT, 2012). *Oryza sativa* and *Oryza glaberrima* are the only two cultivated species of rice while the other species are wild. *Oryza sativa* is commonly grown in Asia, North and South America, Europe and Africa. *Oryza glaberrima* is highly grown in West African but due to higher yields of *O. sativa* and *O. glaberrima-sativa* varieties; it is being replaced in most parts of Africa [3].

There are two classes of rice based on starch content, that is, waxy and non waxy rice. Glutinous or waxy rice in which endosperm starch lacks or has very little amylose content consists mainly of amylopectin starch [4]. The ratio of amylose to amylopectin has a major effect on the physical properties of starch. When cooked, the semi-crystalline structure of rice starch is disrupted thus transforming the starch into a softer, edible, and gel-like material [5]. Generally, the amylose content of milled rice is classified into three classes: waxy (0-2%), very low amylose (3-9%), low amylose (10-19%), intermediate amylose (20-24%) and high amylose (above 24%) [6]. The cooking temperature at which water is absorbed and the endosperm starch granule swell irreversibly with subsequent loss of crystalline structure is referred to as gelatinization temperature (GT) [7]. Gelatinization temperature is an important component of rice cooking quality. Rice grain with low gelatinization temperature takes shorter cooking times leading to significant potential savings in fuel costs [8]. Three classes of GT are recognized in rice breeding programs: high (>74°C), intermediate (70-74°C), and low (<70°C) [9,10]. Besides waxy and alk genes that controls amylose content and gelatinization temperature in rice, there are other several QTLs within the rice genome that are linked to these two genes.

There is a wide range of rice varieties grown both in Kenya and Tanzania. These rice cultivars are either local landraces or improved varieties and they express different levels of amylose and amylopectin that influences amylose content and gelatinization temperature in rice respectively. Since these two traits are key determinant in cooking and eating qualities of rice, unscrupulous traders often blend rice grains which have good cooking and eating quality traits with grains which have poor cooking and eating quality traits based on amylose content and gelatinization temperature to make more profit from their trade. This causes a negative impact on rice trade and consumption. Accurate evaluation of these two traits is difficult and has hindered development of better varieties with good eating and cooking qualities by rice breeders both in Kenya and Tanzania. The various physicochemical methods commonly used to determine amylose content and gelatinization temperature in rice are often inaccurate and time consuming. However, genetic diversity analysis on these selected rice genotypes from Kenya and Tanzania based on amylose content and gelatinization temperature using microsatellite markers has not yet been studied.

Molecular markers can have a number of applications in agriculture, and their application in rice improvement has been reviewed [11]. Simple Sequence Repeat (SSR) markers are easily available for any

*Corresponding author:

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could be due to different group of rice genotypes used. The high level of similarity recorded by this author could be due to the intra specific variation in the germplasm used.

On comparing Kenyan and Tanzanian rice genotypes, it was found that Kenyan genotypes were closely related compared to Tanzanian genotypes, with a mean genetic dissimilarity coefficient of 0.3939 against that of 0.5064 for the Tanzanian genotypes. The genetic closeness of Kenyan rice varieties could be as a result of high intra specific variation, evolution from a common ancestry and introgression of similar traits during the time of genetic improvement. On the other hand, the relatively high genetic dissimilarity witnessed among the Tanzanian varieties could be as a result of having diverse ancestral origins, high gene flow caused by cross pollination among these varieties and chromosomal mutations in their genome.

Clustering of these genotypes together, for example, *BW 196* and *BS 370* could be as a result of sharing common ancestry or similar genes were introgressed into their genome during their breeding. Surprisingly, group I genotypes which were all improved varieties were genetically distinct when compared with the *IR 64* that was used as a check variety. Therefore, based on these results, it is evident that the six improved varieties studied have different levels of amylose content and gelatinization temperature. Thus further breeding on these genotypes should be carried out so as to introgress favorable genes conferring intermediate amylose content and gelatinization temperature in their genome so as to make them highly competitive in rice market.

Supa, a local landrace from Tanzania and *IR 54*, an improved cultivar with low amylose content from Philippine clustered together. Based on these results, these two genotypes share common alleles for *waxy* gene responsible for high amylose content and *alk* alleles associated with low gelatinization temperature. Therefore, *Supa* genotype does not have good cooking and eating quality characteristics. Genes expressing good quality traits should be introgressed into genome of this genotype. *Kilombero*, *Wahiwahi* and *IR 64* were clustered together. Factors such as sharing of common ancestry and gene flow caused by interspecific gene transfer could be reason behind clustering together. Clustering of *Kilombero* and *Wahiwahi* together with *IR 64* is an indication that these two Tanzanian local landraces have good cooking and eating qualities like those of *IR 64*.

Principle coordinate analysis is a method that visualizes similar and dissimilar data. It assigns similar or dissimilar matrix a location in a three dimensional space. It was chosen to complement the UPGMA cluster analysis by visualizing the relationship between the sample genotypes using genetic distances. The Kenyan improved genotypes were clearly separated from Tanzanian local landraces. Genotypes that grouped together were interpreted to have similar characteristics (closely related) while those apart interpreted to be different or distantly related.

Analysis of molecular variance revealed percentage variation between and among the Kenyan and Tanzanian rice genotypes used in this study. The high genetic variation within the sample populations could be due to increased gene flow or mutations of a number of repeats of a given genotype for a given SSR. In addition, natural selection mechanism could be another source of this high genetic variation within the rice genotypes studied. On the other hand, the relatively low genetic variation among these rice genotypes could be attributed by sharing of same SSR profiles among themselves. The low genetic variation among these genotypes could explain the probability of sharing a common ancestry despite the fact that they are grown in

different countries. Similar huge differences in percentage variation between and among a group of rice genotypes studied using SSR markers.

Conclusion

The present study provided an overview of genetic diversity based on amylose content and gelatinization temperature among the rice genotypes studied. The UPGMA cluster analysis showed that all 13 rice genotypes could be easily distinguished based on the information generated by the 8 polymorphic SSR markers. The PIC values revealed that RM 141, RM 225, and RM 434 might be the best markers for identification and diversity estimation of rice genotypes. The genetic distance revealed that the Kenyan genotypes had relatively narrow genetic base compared to the Tanzanian genotypes. Therefore, it is highly important not only to conserve these genotypes, but also to reveal their gene pool and unlock other valuable genes for breeding purposes.

References

- Poppi D, Maitav T, Maitav S, Maitav Y, Maitav Z, Maitav A, Maitav R, Maitav G, Maitav H, Maitav I, Maitav J, Maitav K, Maitav L, Maitav M, Maitav N, Maitav O, Maitav P, Maitav Q, Maitav R, Maitav S, Maitav T, Maitav U, Maitav V, Maitav W, Maitav X, Maitav Y, Maitav Z, Maitav AA, Maitav AB, Maitav AC, Maitav AD, Maitav AE, Maitav AF, Maitav AG, Maitav AH, Maitav AI, Maitav AJ, Maitav AK, Maitav AL, Maitav AM, Maitav AN, Maitav AO, Maitav AP, Maitav AQ, Maitav AR, Maitav AS, Maitav AT, Maitav AU, Maitav AV, Maitav AW, Maitav AX, Maitav AY, Maitav AZ, Maitav BA, Maitav BB, Maitav BC, Maitav BD, Maitav BE, Maitav BF, Maitav BG, Maitav BH, Maitav BI, Maitav BJ, Maitav BK, Maitav BL, Maitav BM, Maitav BN, Maitav BO, Maitav BP, Maitav BQ, Maitav BR, Maitav BS, Maitav BT, Maitav BU, Maitav BV, Maitav BW, Maitav BX, Maitav BY, Maitav BZ, Maitav CA, Maitav CB, Maitav CC, Maitav CD, Maitav CE, Maitav CF, Maitav CG, Maitav CH, Maitav CI, Maitav CJ, Maitav CK, Maitav CL, Maitav CM, Maitav CN, 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Maitav GB, Maitav GC, Maitav GD, Maitav GE, Maitav GF, Maitav GG, Maitav GH, Maitav GI, Maitav GJ, Maitav GK, Maitav GL, Maitav GM, Maitav GN, Maitav GO, Maitav GP, Maitav GQ, Maitav GR, Maitav GS, Maitav GT, Maitav GU, Maitav GV, Maitav GW, Maitav GX, Maitav GY, Maitav GZ, Maitav HA, Maitav HB, Maitav HC, Maitav HD, Maitav HE, Maitav HF, Maitav HG, Maitav HH, Maitav HI, Maitav HJ, Maitav HK, Maitav HL, Maitav HM, Maitav HN, Maitav HO, Maitav HP, Maitav HQ, Maitav HR, Maitav HS, Maitav HT, Maitav HU, Maitav HV, Maitav HW, Maitav HX, Maitav HY, Maitav HZ, Maitav IA, Maitav IB, Maitav IC, Maitav ID, Maitav IE, Maitav IF, Maitav IG, Maitav IH, Maitav II, Maitav IJ, Maitav IK, Maitav IL, Maitav IM, Maitav IN, Maitav IO, Maitav IP, Maitav IQ, Maitav IR, Maitav IS, Maitav IT, Maitav IU, Maitav IV, Maitav IW, Maitav IX, Maitav IY, Maitav IZ, Maitav JA, Maitav JB, Maitav JC, Maitav JD, Maitav JE, Maitav JF, Maitav JG, Maitav JH, Maitav JI, Maitav JJ, Maitav JK, Maitav JL, Maitav JM, Maitav JN, Maitav JO, Maitav JP, Maitav JQ, Maitav JR, Maitav JS, Maitav JT, Maitav JU, Maitav JV, Maitav JW, Maitav JX, Maitav JY, Maitav JZ, Maitav KA, Maitav KB, Maitav KC, Maitav KD, Maitav KE, Maitav KF, Maitav KG, Maitav KH, Maitav KI, Maitav KJ, Maitav KK, Maitav KL, Maitav KM, Maitav KN, Maitav KO, Maitav KP, Maitav KQ, Maitav KR, Maitav KS, Maitav KT, Maitav KU, Maitav KV, Maitav KW, Maitav KX, Maitav KY, Maitav KZ, Maitav LA, Maitav LB, Maitav LC, Maitav LD, Maitav LE, Maitav LF, Maitav LG, Maitav LH, Maitav LI, Maitav LJ, Maitav LK, Maitav LL, Maitav LM, Maitav LN, Maitav LO, Maitav LP, Maitav LQ, Maitav LR, Maitav LS, Maitav LT, Maitav LU, Maitav LV, Maitav LW, Maitav LX, Maitav LY, Maitav LZ, Maitav MA, Maitav MB, Maitav MC, Maitav MD, Maitav ME, Maitav MF, Maitav MG, Maitav MH, Maitav MI, Maitav MJ, Maitav MK, Maitav ML, Maitav MM, Maitav MN, Maitav MO, Maitav MP, Maitav MQ, Maitav MR, Maitav MS, Maitav MT, Maitav MU, Maitav MV, Maitav MW, Maitav MX, Maitav MY, Maitav MZ, Maitav NA, Maitav NB, Maitav NC, Maitav ND, Maitav NE, Maitav NF, Maitav NG, Maitav NH, Maitav NI, Maitav NJ, Maitav NK, Maitav NL, Maitav NM, Maitav NN, Maitav NO, Maitav NP, Maitav NQ, Maitav NR, Maitav NS, Maitav NT, Maitav NU, Maitav NV, Maitav NW, Maitav NX, Maitav NY, Maitav NZ, Maitav OA, Maitav OB, Maitav OC, Maitav OD, Maitav OE, Maitav OF, Maitav OG, Maitav OH, Maitav OI, Maitav OJ, Maitav OK, Maitav OL, Maitav OM, Maitav ON, Maitav OO, Maitav OP, Maitav OQ, Maitav OR, Maitav OS, Maitav OT, Maitav OU, Maitav OV, Maitav OW, Maitav OX, Maitav OY, Maitav OZ, Maitav PA, Maitav PB, Maitav PC, Maitav PD, Maitav PE, Maitav PF, Maitav PG, Maitav PH, Maitav PI, Maitav PJ, Maitav PK, Maitav PL, Maitav PM, Maitav PN, Maitav PO, Maitav PP, Maitav PQ, Maitav PR, Maitav PS, Maitav PT, Maitav PU, Maitav PV, Maitav PW, Maitav PX, Maitav PY, Maitav PZ, Maitav QA, Maitav QB, Maitav QC, Maitav QD, Maitav QE, Maitav QF, Maitav QG, Maitav QH, Maitav QI, Maitav QJ, Maitav QK, Maitav QL, Maitav QM, Maitav QN, Maitav QO, Maitav QP, Maitav QQ, Maitav QR, Maitav QS, Maitav QT, Maitav QU, Maitav QV, Maitav QW, Maitav QX, Maitav QY, Maitav QZ, Maitav RA, Maitav RB, Maitav RC, Maitav RD, Maitav RE, Maitav RF, Maitav RG, Maitav RH, Maitav RI, Maitav RJ, Maitav RK, Maitav RL, Maitav RM, Maitav RN, Maitav RO, Maitav RP, Maitav RQ, Maitav RR, Maitav RS, Maitav RT, Maitav RU, Maitav RV, Maitav RW, Maitav RX, Maitav RY, Maitav RZ, Maitav SA, Maitav SB, Maitav SC, Maitav SD, Maitav SE, Maitav SF, Maitav SG, Maitav SH, Maitav SI, Maitav SJ, Maitav SK, Maitav SL, Maitav SM, Maitav SN, Maitav SO, Maitav SP, Maitav SQ, Maitav SR, Maitav SS, Maitav ST, Maitav SU, Maitav SV, Maitav SW, Maitav SX, Maitav SY, Maitav SZ, Maitav TA, Maitav TB, Maitav TC, Maitav TD, Maitav TE, Maitav TF, Maitav TG, Maitav TH, Maitav TI, Maitav TJ, Maitav TK, Maitav TL, Maitav TM, Maitav TN, Maitav TO, Maitav TP, Maitav TQ, Maitav TR, Maitav TS, Maitav TT, Maitav TU, Maitav TV, Maitav TW, Maitav TX, Maitav TY, Maitav TZ, Maitav UA, Maitav UB, Maitav UC, Maitav UD, Maitav UE, Maitav UF, Maitav UG, Maitav UH, Maitav UI, Maitav UJ, Maitav UK, Maitav UL, Maitav UM, Maitav UN, Maitav UO, Maitav UP, Maitav UQ, Maitav UR, Maitav US, Maitav UT, Maitav UU, Maitav UV, Maitav UW, Maitav UX, Maitav UY, Maitav UZ, Maitav VA, Maitav VB, Maitav VC, Maitav VD, Maitav VE, Maitav VF, Maitav VG, Maitav VH, Maitav VI, Maitav VJ, Maitav VK, Maitav VL, Maitav VM, Maitav VN, Maitav VO, Maitav VP, Maitav VQ, Maitav VR, Maitav VS, Maitav VT, Maitav VU, Maitav VV, Maitav VW, Maitav VX, Maitav VY, Maitav VZ, Maitav WA, Maitav WB, Maitav WC, Maitav WD, Maitav WE, Maitav WF, Maitav WG, Maitav WH, Maitav WI, Maitav WJ, Maitav WK, Maitav WL, Maitav WM, Maitav WN, Maitav WO, Maitav WP, Maitav WQ, Maitav WR, Maitav WS, Maitav WT, Maitav WU, Maitav WV, Maitav WW, Maitav WX, Maitav WY, Maitav WZ, Maitav XA, Maitav XB, Maitav XC, Maitav XD, Maitav XE, Maitav XF, Maitav XG, Maitav XH, Maitav XI, Maitav XJ, Maitav XK, Maitav XL, Maitav XM, Maitav XN, Maitav XO, Maitav XP, Maitav XQ, Maitav XR, Maitav XS, Maitav XT, Maitav XU, Maitav XV, Maitav XW, Maitav XX, Maitav XY, Maitav XZ, Maitav YA, Maitav YB, Maitav YC, Maitav YD, Maitav YE, Maitav YF, Maitav YG, Maitav YH, Maitav YI, Maitav YJ, Maitav YK, Maitav YL, Maitav YM, Maitav YN, Maitav YO, Maitav YP, Maitav YQ, Maitav YR, Maitav YS, Maitav YT, Maitav YU, Maitav YV, Maitav YW, Maitav YX, Maitav YY, Maitav YZ, Maitav ZA, Maitav ZB, Maitav ZC, Maitav ZD, Maitav ZE, Maitav ZF, Maitav ZG, Maitav ZH, Maitav ZI, Maitav ZJ, Maitav ZK, Maitav ZL, Maitav ZM, Maitav ZN, Maitav ZO, Maitav ZP, Maitav ZQ, Maitav ZR, Maitav ZS, Maitav ZT, Maitav ZU, Maitav ZV, Maitav ZW, Maitav ZX, Maitav ZY, Maitav ZZ

Suwannaporn P, Pitiphunpong S, Champangern S (2007). Classification of

precision plant breeding in the É I

