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RESEARCH ARTICLE

EVALUATION OF SEED QUALITY ALONG THE RICE (*Oryza sativa* L.) VALUE CHAIN IN CAMEROON, CASE OF: NDOP, TONGA AND EBOLOWA RICE FARMER'S SEEDS

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ABSTRACT

The scarcity of good quality seeds in Cameroon is among the major constraints in producing quality rice and is one of the main causes of consumers' preference for imported rice. This work, done at the Institute of Agricultural Research for Development (IRAD) Nkolbisson was aimed at evaluating the quality of rice farmers' seeds in the localities of Ndop, Tonga, and Ebolowa. Standard tests of germination rate, moisture content, and seed purity were performed using the following varieties: NERICA L 42, Tox 4133 and Tainan from Ndop; NERICA 8, NERICA L 56, CICA 8, Cholera and Toubem from Tonga and finally NERICA 8, NERICA 3 from Ebolowa. Results showed that varieties from Tonga exhibited a good germination rate and varietal purity; Only NERICA L 56 (98.7%) exhibited a better specific purity while cholera (99.03%) and NERICA-8 (99.6%) showed a better varietal purity. Varieties from Ndop; Tox 4133 showed a poor germination rate (84.66%) and NERICA L -42 for specific purity (94.43%) and varietal purity (79.26%). Ebolowa varieties had better germination rate and moisture content but with poor specific purity and germination rate for NERICA 8. None of the seed samples met all the Ministry of Agriculture and Rural Development minimum requirements for quality seeds; inappropriate farming practices during pre-and post-harvest management by farmers could be the cause, thus a rationale for the preference of imported rice over local rice. Some production and conservation practices have been recommended, so as to improve on farmers' rice seeds in these localities.

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INTRODUCTION

Rice (*Oryza sativa* L.) is a short-day annual crop grown under diverse climatic and edaphic conditions. It grows well in humid tropical regions with high temperature, plenty of rainfall and sunshine in heavy clay or clay loam soils. The role of rice crop is inevitable in the current and future global food security. Worldwide, it is grown in Asia, Americas, Australia, Europe and Africa following diverse production practices (Chauhan and Jabran, 2017) with highest production in china (mainland), followed by India, Indonesia, Bangladesh and Vietnam respectively (FAO, 2018). In Africa, rice has over the decades become a staple food crop for most communities because, coupled with the ease to prepare, its price has remained relatively stable for over 15 years.

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Becoming a vital tool for combating hunger and reducing poverty, governments use agriculture and trade policies, such as import tariffs, to build up the rice sector's competitiveness. In 2018, Nigeria recorded the highest paddy production in Africa, followed by Egypt, Madagascar and Mali respectively (FAO, 2018). In Cameroon, it is one of the basic foods and the overall cereal after maize (Fofiri *et al*., 2008). Back in 2000, the country imported 155,472 tons of rice for CFA 156.6 billion. During the peak year 2013, rice import stood at 819,841 tons for CFA 212.6 billion (NIS. 2018). Self-contradictorily with considerable internal production potential, rice cultivation by the populations of North West and Far North regions, as well as small scale production in localities of Tonga, Koutaba; and despite natural favourable conditions to its cultivation, it is the cereal for which the country knows a strong international dependence. This dependence created a social, economic and political crisis in 2008.

As a result, MINADER through its projects (PRODERIP and PFPRI-Avangane), decided to boost rice production in Cameroon by ways of producing and popularizing its cultivation throughout the entire territory. By so doing, the country's actual annual production fluctuates between 160 000 – 170 000 tons, which is mostly exported than consumed due to either the quality or selling price, as many consumers and traders complains (NIS 2018). Section 2 of Cameroon law N° 2001/014 of the 23rd of July 2001 defines a seed as 'all or part of a plant organism enabling the multiplication or its production thereof, namely a grain, cutting, seedling, sucker, tuber, bulb, spore or vitro plant, and farmers require seed that meet the following five main criteria; It should be of right quality, available in the right quantities, at the right time, at the right place and of the farmer's choice (Tata et al., 2016).

Seed quality can be considered as the summation of all factors that contribute to seed performance. High quality seed enables farmers to attain crops, which have: The most economical planting rate; a higher percentage of seeds emerging in the field; a minimum of re-planting; a vigorous seedling establishment; a more uniform plant stand; faster growth rate, and greater resistance to stress and diseases; uniformity in ripening (IRRI, 2013). High quality seeds are the result of good production practices such as: Proper maintenance of genetic purity; Good growing conditions; Proper timing and methods of harvesting; Appropriate processing during threshing, cleaning and drying; Appropriate seed storage and seed distribution systems (IRRI, 2013). Acceptable seed certification rules and norms or standards have to satisfy the MINADER requirements (MINADER, 2006) in table 1.

The rice seed, also known as caryopsis is a dry one seeded fruit with its pericarp fused with the seed coat. The outer covering is called the hull (lemma, palea, awn or tail, rachilla and two sterile lemmas), and account for 20% of total seed weight (Warrier and Tripathi, 2011). The endosperm (contains sugars, fats, crude fibre and organic matter) is the store house of embryonic food (Wopereis et al., 2009). The grain length varies with cultivars between 5 and 7mm and grains can be round, bold or slender (Warrier and Tripathi, 2011). The quality of rice is not always easy to define as it depends on the consumer and the intended end use for the grain. Consumers want the best quality that they can afford and the demand for this is alarming. Grain quality is not just dependent on the variety of rice, but also depends on the crop production environment, harvesting, processing and milling systems (Badi and Osamu, 2013). The production of good quality rice begins from seeds through the use of quality seeds. With the possession of vast stretches of arable land, fertile soils and good rainfall, returns from these natural assets are not enough to feed Cameroon's growing population of whom has rice as their staple food (Nkwain, 2013). Meanwhile, in the national strategy for rice development (NSRD) 2009, the government put forward several strategies to meet these challenges amongst which; the lack of selected rice seeds, so as to develop rice production in Cameroon. As a results, government structures such as UNVDA Ndop, SEMRY Maroua, and PRODERIP produces and distribute tons of quality seeds to its farmers. They also train the latter in appropriate seed selection techniques and good number of them are now involved in quality seed production (Viban, 2013). Despite these efforts by the government to boost quality rice production in Cameroon, the expected level of quality rice production was not attained. In 2018 horizon, it was fixed at 650 000 tons (PRODERIP, 2015). Meanwhile in 2017, production was situated at 360 000 tons (FAO, 2017). Meanwhile available information from FAOSTAT states that Cameroon rice/paddy production in 2015, 2016, 2017 and 2018 was 278 281 tonnes, 359 320 tonnes, 360 000 tonnes and 332 534 tonnes respectively. While 98% of rice consumed is imported from Asia (up to 85% from Thailand, 7% from India and 2% from Myanmar) (NIS, 2018). More than 600 000 tons of rice is needed to meet local demand. In 2018, rice production failed to reach the volume projected by PRODERIP and it keeps reassuring the government to increase production by 2020. However, in 2011, PRODERIP distributed about 75 000 tons of rice seeds to farmers but recently no seed production was lunched due to the COVID-19 pandemic, thus, quality seeds are scarce and farmers are on their own.

Some farmers tend to be contented with primitive variety of seeds due to some reasons amongst which, the high cost price of quality rice seeds. Meanwhile, a competitive production of quality rice seeds will reduce the cost price of the latter. The problem of non-competitive production of quality rice seeds is what this study addresses. Since the production of good quality rice depends firstly on the varietal seed quality used, the study seeks to evaluate the quality of rice farmers' seeds in the localities of Ndop, Tonga and Ebolowa.

MATERIALS AND METHODS

Study site: This study was carried out at general directorate of the Institute of Research for Agricultural Development (IRAD Nkolbisson, Yaounde); at the directorate of scientific research (DRS) and precisely at the annual crops coordination. Nkolbisson is situated at latitude 03°51' North and longitude 011°27' East (Melie *et al.*, 2016), and located in the center region of Cameroon, Mfoundi Division, Yaoundé VII Sub-Division. Varieties of rice seeds samples were collected from local rice farmers; in Badounga (Tonga), they were; CHOLERA, NERICA L-56, Toubem, NERICA 8 and CICA 8, in Ndop; Tox 3145, TAINAN and NERICA L- 42, and at Ebolowa; NERICA 8 and NERICA 3.

Methods

Determining seed moisture content: An electronic moisture tester (riceter F501 – handheld portable moisture tester) was turned on and set for paddy. The tray was filled with the different rice seed samples successively in three replicates. The knob was then rotated clock wisely and the "measure button" pressed to display moisture content percentage.

Assessing early growth characteristics: This consisted of the germinating test where, cotton wool was placed into three petri dishes per variety (3 replicates). The cotton wool was moist with tap water. Into each plate, 100 grains of rice seeds were selected from each seed lot and placed in a sparsely distribution manner based on each variety. The latter were checked each day to moisten the medium further until germination, and after 7 days the number of germinated seeds were recorded. Germination rate was calculated using the average number of germinated seeds and based on the following formula (IRRI, 2018).

$$\% \text{ Germination} = \frac{\text{N° of germinated seeds}}{\text{Total N° of seeds}} \times 100$$

Determining seed lot specific and varietal seed purity: For seed lot purity 100g of seed samples was measured using an electronic balance, weeds were sorted out and weighed. The percentage of weeds was then determined as in the following formula (IRRI, 2018).

$$\% \text{ Weeds} = \frac{\text{weight of weeds}}{\text{Total weight of sample}} \times 100$$

Inert matter were also sorted out and weighed then its percentage was calculated using the formula (IRRI, 2018).

$$\% \text{ Inert Matter} = \frac{\text{weight of inert matter}}{\text{Total weight of sample}} \times 100$$

For the determination of varietal purity, 100g of each seed samples were measured and varietal impurities sorted out. The varietal purity was then weight and the percentage purity was calculated using the formula (IRRI, 2018).

$$\% \text{ Purity} = \frac{\text{weight of purity}}{\text{Total weight of sample}} \times 100$$

Data analysis: Data collected were entered and organised through excel spread sheets. The latter were analysed with R 4th version, using Shapiro-Wilk test to verify conditions for data normality. Mean separation was done with the aid of Duncan's multiple range test.

RESULTS AND DISCUSSION

Results

Farmer's rice seeds evaluation from Tonga: Analysis of variance showed that germination rate, moisture content, specific and varietal purity of farmer's seeds from Tonga with MINADER certified seeds (MICES) were significantly different (P ≤ 0.01). Furthermore, Cholera registered the highest mean germination rate (GR) (97. 33%), while NERICA 8 had the lowest with 86.66% GR. However, all the varieties registered a good GR as compared to MINCES in spite of the fact that NERICA 8 had a GR below that of MINCES, there is no statistical difference as can be seen on figure 1. As for moisture content, CICA 8 registered the highest mean MC (15.50%) while MINCES had the lowest with 12% GR and it is the recommended MC for good seeds. We see that there is a statistical difference between all the varieties from MINCES as seen on Figure 1. In the case of specific purity, we observed the highest mean in MICES (98.00%); the minimum recommendation for good seeds according to MINADER, 2006. NERICA 8 had the lowest with 86%. Apart from NERICA L 56 (97.80%) which has no significant difference with minimum recommendation, all the other varieties are not specifically pure because they differ from MINCES as seen on Figure 1. Meanwhile minimal recommendations are at 98% (MINCES) and only cholera and NERICA 8 are of good quality in terms of basic varietal purity, therefore all the other varieties are not pure.

Rice seeds quality evaluation of Ndop farmers: Analysis of variance showed that there was a significant difference (P≤ 0.01) between germination rate of farmer's seeds from Ndop and MINADER certified seeds (MINCES). Also, a significant difference (P≤0.001) was observed in their moisture content, specific and varietal purity. Results in figure 2 shows that, NERICA L-42 registered the highest mean germination rate (96.33%), while TOX had the lowest with 84.66%. However apart from TOX, all the varieties registered a good germination rate as compared to MINCES thus significant different from MICES GR. As for Moisture content, a significant difference between the samples was observed. TOX registered the highest mean (15.13%) while TAINAN had the lowest with 11.53%. TOX registered the highest mean (98.50%) for specific purity while NERICA 8 presented the lowest with 86%. Apart from NERICA L 42 (94.43%) which is significantly different from minimum recommendation (98.00%), all the other varieties are specifically pure. As for varietal purity, Figure 2 also shows a maximal and minimal mean in TAINAN and NERICA L-42 with 99.33% and 79.26% VP respectively. Meanwhile minimal recommendations are at 98% (MINCES) and we see that only TAINAN is of good quality in terms of basic varietal purity.

Rice seeds quality evaluation of Ebolowa farmers: Analysis of variance showed that germination rate and specific purity of these seeds with MINADER certified seeds (MICES) was significantly different (P≤ 0.001), meanwhile a significant difference was observed in varietal purity (P≤ 0.01) and moisture content (P≤ 0.05). MICES registered the highest mean germination rate with 90.33% while NERICA 8 had the lowest with 61.66%. However, NERICA 3 registered 83.33% and does not differ significantly from the minimal requirement. On the other hand, NERICA 8 having below minimum recommendation has a germination rate as can be seen in figure 3. As for moisture content we observe no significant difference between the varieties. Thus all Ebolowa seed samples had good moisture content as they didn't differ from the minimum recommendations (12%) of MINADER. We observed the highest mean specific purity in MICES (98%) while NERICA 8 and NERICA 3 had 89% and 93.50% and thus were not specifically pure. This results is similar to what Tang and Ngome, 2015 discovered in NERICA L 56 and NERICA 8 when they assessed their quality. This is generally linked to farmer practices. As varietal purity was concerned, these seeds both registered (100%) means above the minimal recommendations of 98% (MINCES) as can be seen in figure 3.

DISCUSSION

Farmer's rice seeds evaluation from Tonga: Although stored in polythene bags, GR of these seeds were generally good due to the fact that their storage period had not been more than 6 months as IRRI, 2013 stipulates. Where GR was below standard, storage material was not the best as Tang and Ngome, 2015 recommend nylon bags in addition to good production practices. Acceptable MC as MINADER, 2006 recommends can be attained certainly when good production management are practiced.

Table 1. MINADER Seed Certification Rules and Standards

Characteristics	Basic seeds	Certified seeds
Purity (minimum)	98%	98%
Minimum germination potential	80%	90%
Moisture content in sowed bag (maximum)	12%	12%
Maximum content in seeds of other crop species and weeds	0%	0%
Maximum content in inert matter (stones, soil etc)	2%	2%

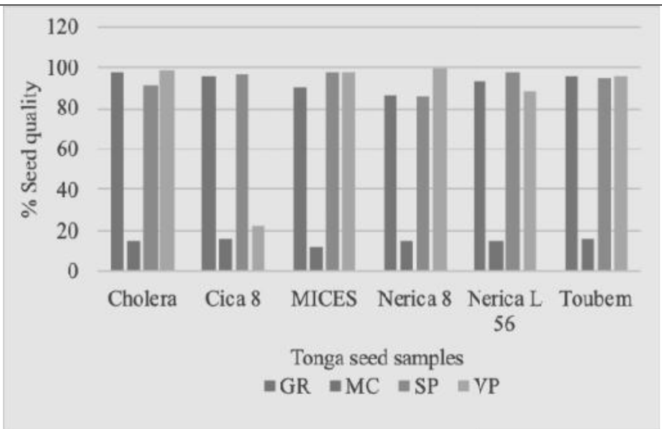

Figure 1: Quality level of Tonga samples. All the varieties registered a good GR (germination rate) as compared to MINCES in spite of the fact that NERICA 8 had a GR below that of MINCES, there is no statistical difference. CICA 8 registered the highest mean moisture content (MC) (15.50%) while MINCES had the lowest with 12% GR and it is the recommended MC for good seeds. There's a statistical difference between all the varieties from MINCES. Apart from NERICA L 56 (97.80%) which has no significant difference with minimum recommendation for SP (Specific purity). only cholera and NERICA 8 are of good quality in terms of basic VP (varietal purity), therefore all the other varieties are not pure.

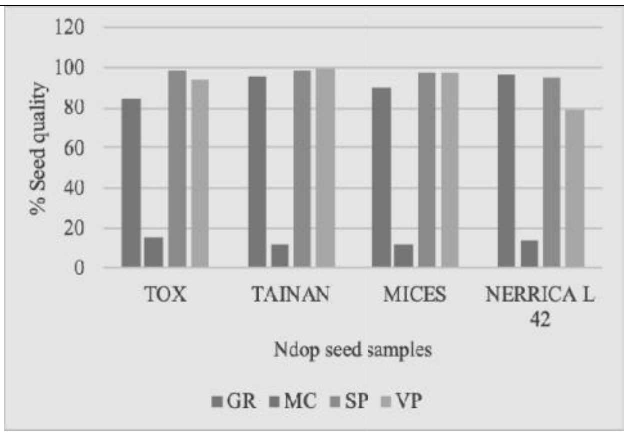

Figure 2: Representation of mean parameters of Ndop farmer's rice seeds. Samples are of good quality in terms of germination. TOX registered the highest mean (15.13%) while TAINAN had the lowest with 11.53% for Moisture content testifying a significant difference between the samples. all the varieties are specifically pure apart from NERICA L 42 (94.43%) which is significantly different from minimum recommendation (98.00%). only TAINAN is of good quality in terms of basic varietal purity.

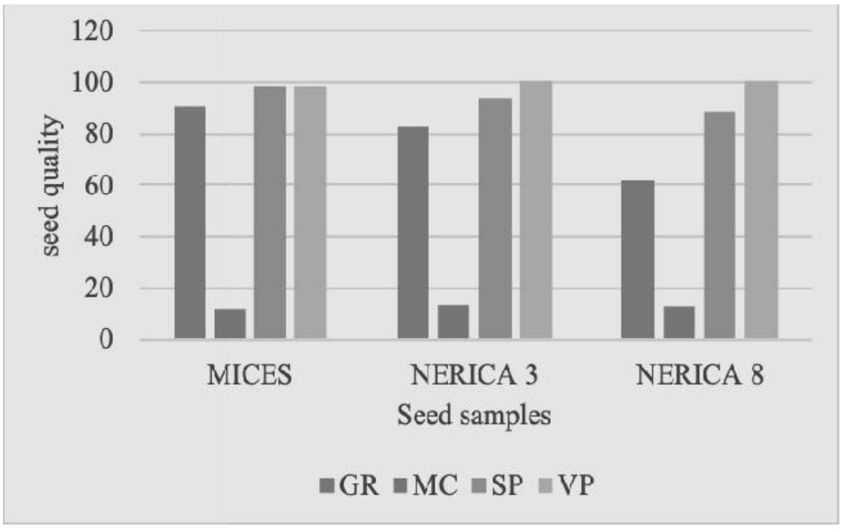

Figure 3: Representation of mean parameters of Ebolowa farmer's seeds. NERICA 3 registered 83.33% and does not differ significantly from the minimal requirement. NERICA 8 is below minimum recommendation in germination rate. All seed samples has good moisture content as they didn't differ from the minimum recommendations (12%) of MINADER. specific purity in MICES (98%) while NERICA 8 and NERICA 3 had 89% and 93.50% and thus were not specifically pure. these seeds both registered (100%) above the minimal recommendations of 98% (MINCES)

However, the others with MC above standard, reaping time, drying and storing were poorly done in contrast to IRRI, 2013 and Tang and Ngome, 2015 who recommend storing in sealed containers to prevent moisture absorption from the environment. Impurities such as seeds of weeds, inert materials (stones, twigs or dirt), unfilled grains and poor seed sizes were discovered in most of the samples. This results is similar to what Tang and Ngome, 2015 discovered in NERICA L 56 and NERICA 8 when they assessed their quality. This is generally linked to farmer practices. The maximal and minimal mean varietal purity was seen in NERICA 8 and CICA 8 with 99.60% and 22% respectively.

Some of the seed samples were full of varietal impurities (CICA 8) due to insufficient mastery on the different varieties cultivated by the farmers leading to contamination at any level during the handling the varieties.

Rice seeds quality evaluation of Ndop farmers: From the results obtained, Ndop seed samples are of good quality in terms of germination with the exemption of TOX due to poor production practices such as poor growing conditions, harvesting time, processing during drying and storage. Good germination rate of the other samples was due to the fact that they had not reached up to 6 months of storage and therefore in contrast to IRRI 2013 which states that germination rate of most rice seeds begins to deteriorate rapidly after 6 months. MINADER in 2006 recommends 12% MC for good seeds as result for MINCES showed in figure 2. Thus none of the others presented the required moisture content for good quality; and this could be due to poor mastery of reaping time, drying and storing in contrast to IRRI, 2013 and Tang and Ngome, 2015 recommends storing in sealed containers to prevent moisture absorption from the environment. The results for Ndop seeds specific purity contradicts that of Tang and Ngome, 2015 who discovered in NERICA L 56 and NERICA 8; But however similar to their results for varietal purity due to a general linkage to farmer practices as impurities such as seeds of weeds, inert materials (stones, twigs or dirt), unfilled grains and poor seed sizes were discovered in most of the samples.

Rice seeds quality evaluation of Ebolowa farmers: The results obtained for germination rate of Ebolowa seeds can be explained by the presence of MINADER rice project (PRODERIP certified rice seed multiplication farm), who provide farmers with rice seeds every cropping season. And also due to storage duration (less than 6 months) IRRI, 2013; seed quality. They also had good moisture content due to proper post-harvest management of the seeds for the same reason. NERICA 8 and NERICA 3 of these farmers' seeds were not specifically pure as it was the case in NERICA L 56 and NERICA 8 of Tang and Ngome, 2015 discovery; it is generally linked to farmer practices. The explanation for the good varietal purity obtained is due to the adequate measures in the seed production by the MINADER project situated in this area, thus farmers benefit.

Conclusion

In the light of this study's results which was all about evaluating seed quality of rice farmers in some localities of Cameroon, it appears that some of the seed samples thrived toward acceptable quality seeds, but a general poor quality of the latter was discovered. In Tonga, all the varieties were poor in moisture content. NERICA 8 had a poor germination rate while Toubem, CICA 8 and NERICA 8 were specifically impure. Toubem, NERICA L 56 and CICA 8 were poor in varietal purity. In Ndop, all the varieties didn't present an acceptable moisture content. Tox and NERICA L- 42 performed poorly in germination and specific purity respectively. NERICA L- 42 and TOX had poor varietal purity. In Ebolowa, both varieties didn't portray an acceptable specific purity. NERICA 8 didn't display an acceptable germination rate. Therefore, none of the localities seed samples met all MINADER minimum requirements for good quality seeds. This could be due to the inappropriate pre and post-harvest management of the seeds as earlier discussed. As a result, they cannot be considered as seeds and thus cannot be recommended for quality rice production. This can be a rational for consumers' preference for imported rice over locally produced rice.

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Key-points

- This article presents the state or quality of farmers' rice seeds in some localities in Cameroon;
- Tonga, Ndop and Ebolowa farmers' seeds were poor in quality (poor germination rate, moisture content and impure in variety) according to Cameroon MINADER norms for seeds quality;
- Thus, these seeds cannot yield quality rice needed by consumers and this is one the *"raison d'être"* for preference of imported rice over locally produced rice.

Glossary of Abbreviations

CRTV: Cameroon Radio and Television
DRS: Directorate of Scientific Research
FASA: Faculty of Agronomy and Agricultural Sciences
GR **:** Germination rate
IRAD: Institute of Agricultural Research for Development
IRRI: International Rice Research Institute
JICA: Japan International Cooperation Agency
MC: Moisture content
MINADER: Ministry of Agriculture and Rural Development
MICES **:** MINADER Certified seeds
NERICA: New Rice for Africa
NIS: National Institute of Statistics
NSRD: National Strategy of Rice Development
NSRG: National Strategy for Rice Growing
PRODERIP: Upland Rainfed Rice Cultivation Development Project in the Bimodal Rainforests Zones
PFRIA-C: Pilot Rice farm Project of Avangane, Central Region of Cameroon
SEMRY: Yagoua Rice Growing Expansion and Modernization Company
UNVDA: Upper Noun Valley Development Authority
VP: Varietal purity

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