Enhancement of Productivity, Value Addition and Utilisation of Dual-purpose Pumpkin among smallholder farmers in Kenya

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BACKGROUND

Pumpkin (*Curcubita moschata* Duch.) in an emerging fruit-vegetable that belongs to the family Cucurbitaceae and is known by various other vernacular names. It originated in Central to South America, from where it has spread to many other continents, including Africa where it has become naturalized and is categorized among indigenous vegetable (Abukutsa-Onyango, 2007). In 2000, worldwide production of pumpkins stood at 16 million tons from 1.3 million ha, while production in Africa was approximately 1.8 million tons on 140,000 ha, yielding 12.8 t/ha on average. On a global scale, pumpkin is amenable to making many products using its tender leaves or mature fruits. However, preferences vary from region to region. Leaves are the main edible product in African countries, leaving fruits under-utilized (Abukutsa-Onyango, 2003). In West Africa, seed consumption is common. In Asian countries, pumpkin seeds have several medicinal applications such as anti-helmintic and skin ailments relief. Pumpkin is an important food because most parts of the plant can be eaten and are rich in nutrients (Holland et al., 1991). Pumpkin is very rich in carotenoids that keep the immune system strong and healthy. Pumpkin beta-carotene is a powerful antioxidant and anti-inflammatory agent. It helps prevent build up of cholesterol in arteries, thus reducing chances of strokes. Being rich in alpha-carotene, pumpkin slows down aging and prevents cataract formation. Pumpkins reduce the risk of macular degeneration that usually results in blindness. Pumpkin's high fiber improves bowel health, potassium lowers hypertension risk, and zinc boosts immune system and bone density.

STATEMENT OF THE PROBLEM

Pumpkin is neglected in formal research and is most under-utilized in African countries. Cultural practices in African countries are still extensive, while seed, fruit and leaf vegetable yields are depressingly low due to a combination of poor agronomic practices. Almost no improvement for high and premium seed, fruit and leaf vegetable yields, pest resistance and quality has been performed in African countries. Preferred local African landraces risk disappearing due to introduction of exotic cultivars, and their seeds are in perpetual short supply. Pumpkin is little produced, commercialised and consumed in Africa. Meagre value addition is done to pumpkins found in African markets. No export statistics exist in the Kenyan Horticultural Crops Development Authority on-line databases. Processed products of the fruit are virtually nil in African countries. There is exists no documented pumpkin value chain (PVC), preference and consumption trends in Kenya.

RESEARCH JUSTIFICATION

Pumpkin is a multi-purpose, easy-to-cultivate crop with high nutritional and medicinal values. Pumpkin plants produce large leaves and fruits usable in diverse ways. De-veined tender leaves and mature fruits are cherished by rural folk and certain urban dwellers. Fruits have a tough rind that prevents bruising during transportation to distant markets, thereby helping prolong shelf-life.

Identification and conservation of landraces will provide germplasm for improving cultivars for pest-resistance, fruit, leaf and seed yields, depending on consumer-preferred usage. Streamlining certified seed supply and improving crop management will prove a boon to growers looking for alternative high-value crops to help boost and sustain their livelihoods. Boosting certified seed supply, crop production and value addition will increase income generation for growers, as well as food security and foreign exchange earnings for the country. These milestones will benefit all value chain stakeholders, including crop germplasm conservators, plant breeders, inputs suppliers, crop producers, retailers, wholesalers, exporters, processors and consumers. A documented PVC, preference and consumption trends in Kenya will enable all stakeholders identify gaps, constraints and potential benefits, and thereby develop effective intervention or exploitative measures and policies.

GOAL/PURPOSE

To collect, evaluate, characterise and conserve germplasm, increase productivity and value of the under-utilized, dual-purpose pumpkin for enhanced incomes, economic growth, food and nutrition securities.

GENERAL OBJECTIVES

Improve dual-purpose pumpkin production, processing, packaging technologies and develop innovative processed products for consumers.

SPECIFIC OBJECTIVES

1. Collect, evaluate, characterize and conserve pumpkin germplasm in Kenya.
2. Develop pure seeds of dual-purpose pumpkin in Kenya.
3. Develop optimal crop management packages for sole pumpkin production.
4. Add value to fresh produce and develop new recipes for pumpkin produce

OUTPUTS

1: Preferred landraces of dual-purpose germplasm identified and preserved.

2: Production of indigenous vegetables (pumpkins) improved through:

- Crop Improvement
- Agronomic practices

3: Postharvest handling, value addition and utilization of pumpkins improved through:

- Improvement of post harvest handling technologies
- Value addition and recipe development
- Produce transformation and utilization

4: Mechanisms for information, communication and knowledge sharing developed through:

- Information, communication and knowledge sharing

BENEFICIARIES OF THE OUTPUTS AND OUTCOMES

1. Small-scale and resource-poor farmers will gain adaptable and preferred cultivars.
2. Resource-poor farmers will have easy access to high quality and quantity seeds.
3. Small-scale growers will have proven cropping systems for commercial production.

4. Consumers and sellers will have diverse processed food products with prolonged shelf-life to choose from to improve their nutrition and to satisfy customer needs, respectively.
5. Processors, chefs and consumers will have new and diverse recipes for preparing delicious foods and meals.
6. Postgraduate students will have projects to work on to earn higher degrees.
7. Agro-industries will benefit from the skilled graduates and increased pumpkin raw materials for processing.
8. Scientific community will benefit from the publications, protocols and literature availed.

RESEARCH PLAN/METHODOLOGY

1. Collect, evaluate, characterize and conserve pumpkin germplasm in Kenya

Collection will be conducted in Western and Central Kenya. A questionnaire will be administered in these regions to document the pumpkin value chain. Seeds will be extracted from fruits, washed to remove pulp, air-dried and planted in pots in a greenhouse to raise plants for evaluation and characterisation. Characterization of landraces will use both morphological and molecular techniques (Chigwe and Saka, 1994; Gwanama et al., 2000; Grubben and Chigumira-Ngwerume, 2004). Code-numbered seed samples of landraces will be deposited in the Kenya Plant Genetic Resources Gene Bank. The landraces will be evaluated and selected based on growers' and consumers' demands such as high yields, early maturity, good flavour and size, drought tolerance and pest tolerance.

2. Develop pure seeds of dual-purpose pumpkin in Kenya.

Best-performing landraces will be planted to multiply seeds in pure standards on-station and on-farm. On-farm seed production and saving will be taught to smallholder farmers, emphasizing growing of preferred pumpkins in isolation and exclusively for seed production, extraction, drying, packaging and storage for later use. Choice of landraces to save and their quantity will depend on preference and size of future planting (Abukutsa-Onyango, 2007).

3. Develop optimal crop management packages for sole pumpkin production.

3.1. The effect of farmyard manure and leaf harvesting intensity on productivity will be investigated. Cattle farmyard manure (FYM) is expected to work through soil fertility enhancement, moisture stress amelioration and source-leaf renewal. Farmyard manure will be interacted with LHI to study how they influence leaf and fruit yields (sink-source relationship). For each province the adapted and preferred variety of pumpkin will be planted during the long and short rains.

3.2. Effect of irrigation will be studied with a view to promote year-round or semi-arid regions production. Leaf harvesting intensity will be interacted with irrigation rate. The most preferred cultivar will be used in each target region.

4. Add value to fresh produce and develop new recipes for pumpkin produce

4.1. Food processors, including bakeries, hotels and restaurants will be approached to include pumpkin produce in their foods. The products will be offered to buyers and consumers through supermarkets, bakeries, hotels and restaurants and preference assessed.

4.2. Value addition strategies for and by producers, sellers and processors to be investigated include leaf or fruit drying, waxing whole fruits, wrapping, slicing and mixing in pre-diced vegetables for busy customers. The products will then be offered to consumers through selected supermarkets and retailers.

4.3. Surveys will be conducted to document usage modes in the target regions and to guide researchers in development of recipes for preferred and new products. A schedule for gauging popularity will be developed to capture: frequency of use, preference by gender, reasons mode is preferred, reason not preferred, ingredients and proportions used. The cuisines will be blended and samples taken to determine nutritional contents following standard protocols (AOAC, 1995; Okalebo et al., 2002).

MAJOR ASSUMPTIONS AND RISKS

1. Resources and funding will be adequate to support the proposed research activities.
2. Local communities will be willing to share their crop germplasm with the researchers.
3. Seed production and food processing companies will be willing to partner in this project.
4. The weather will be conducive to allow successful completion of field experiments.
5. Pumpkin will continue gaining popularity among local and urban consumers.
6. Postgraduate students will be willing to pursue advanced studies in this fruit vegetable.
7. Collaborators will be commitment to play their part successfully.
8. One or more of the above-mentioned assumptions will not hold true.

PRELIMINARY RESULTS

The research has been implemented successfully in Kakamega and Nyeri KAPAP Regional Service Units (RSUs) as well as Chuka, KARI-Embu and KARI-Kabete.

Output 1. Vegetable Production Enhanced

1.1.1b Germplasm collection, evaluation and selection

1.1.3b Seed bulking and distribution of selected pure seeds of pumpkins

- Germplasm was collected in the KAPAP recommended Kakamega and Nyeri RSUs.
- Accessions were planted on Chuka University Farm to provide material for evaluation.
- Morphological characterisation and evaluation was based on IPGRI descriptors.
- Farm evaluation of baby trials is continuing on farmers' farms in the RSUs.
- Mother trials first round are continuing at KARI Kakamega and Embu.
- Among the 155 accessions collected 8 accessions failed to germinate and 1 accession died before the commencement of data collection.
- 146 accessions gave data on vegetative, stem, root and inflorescence characters.
- Only 126 accessions formed fruits.

Morphological characters recorded were:

- Nodes to the first fruit,
- Stem thickness,
- Leaf ratio,
- Days to first flowering,
- Days to 50% flowering,
- Penduncle length,
- Fruit flesh thickness,
- Fruit length width ratio,
- Days to first mature fruit,
- Maturation period and
- Total fruit weight.



Nyeri pumpkins



Kakamega pumpkins

- Significant variability was found among 146 accessions of cucurbits.
- Fruit weight ranged from 0.5 to 19.3 kg per accession.
- Fruit length/width ratio ranged from 0.7 cm to 2.1 cm.
- Morphological traits that varied greatly were fruits.
- All accessions had leaf veins, large leaf size, leaf pubescence density-adaxial was dense while abaxial was intermediate, leaf lobes were shallow, leaf base shape was cordate.
- Leaf shapes were pentalobate and all accessions had roots at internodes.
- Leaf outline of 108 accessions was broadly ovate.
- Most accessions (101) were variegated i.e. green with silvery strips.
- 45 accessions were either solid green or dark green.
- 88 accessions showed moderate senescence when fruits matured.
- 44 accessions portrayed conspicuous concurrent senescence.
- All accessions were monoecious.
- Most flowers were male.
- Most male flowers were earlier than female flowers.
- 9 accessions had female flowers appearing before male flowers.
- Flower colour varied.
- Most accessions (101) had orange flower colour.
- 38 accessions exhibiting globular shape.
- 42 accessions had an average fruit size averaging 1.2 kg.
- One accession matured within the range of 91-110 days.
- Delay in fruit maturity was due prolonged drought.
- 99 accessions regenerated second fruit cycle after harvest.
- 27 accessions had no signs of second fruit cycle as vegetative part dried up.

- Predominant fruit skin colour at maturity ranged from green to orange.
- Secondary fruit skin colour pattern that varied from speckled to striped.
- Fruit surface ranged from smooth to skin surface with warts, and
- Internal flesh colour ranged from white to yellow.
- Main colour of outer layer ranged from yellow to salmon (pink-red).
- All the accessions had fruit vein tracks and the peduncle abscised when overripe.
- Deep fruit ribbing was in 40 accessions and 69 accessions had small blossom scars.
- Kakamega accessions yielded (310 kg), compared to Nyeri's (183.75 kg) in total.
- Min and max fruit weight in Kakamega was 0.5 kg & 19.25 kg/accession, respectively.
- Min and max fruit weight in Nyeri was 0.25 kg & 8 kg/accession, respectively.
- Average fruit weight for the Kakamega accessions was 4.8 kg.
- Average fruit weight for Nyeri accessions were 2.96 kg.
- It took more days for fruits in the Nyeri region to mature.
- Kakamega accessions had more thick fleshed fruits.
- Kakamega accessions showed more variation in characters.
- Nyeri accessions showed variation in flowering, maturation, and stem girth.
- Green-leafed accessions were very vulnerable to pests and diseases compared to variegated accessions.
- Green-leafed accessions fruited early but most aborted and didn't reach maturity.
- Green-leafed accessions fruit number averaged 1 fruit per accession.

Conclusions

- There is great variation in pumpkins in Kenya.
- Cultivars seem to be interbreeding a lot.
- Conservation of naturalised germplasm needs to be expedited to save it from further distortion and extinction.

Continuing Work on Germplasm

- Mother trials evaluation of performance: By researchers
- Baby trials evaluation of performance: By farmers
- Mother versus baby trials determine whether results on-stations of researchers can be replicated on-farms of growers.
- Molecular characterisation
- Pure seed bulking of preferred landraces
- Distribution of pure seeds to farmers
- Farm-saving of seeds
- Germplasm conservation with the GBK

Challenges in Germplasm

- Activities are expensive
- Funding is inadequate
- Coverage of all of Kenya as desired proved costly
- Professional expertise is expensive and hard to secure

1.2.2a Integrated Soil, Water and Nutrient Management

Subproject Title: Mineral nutrients sources and leaf harvesting intensity (LHI) effects on fruit and leaf vegetable yields

Research Sites: Nyeri and Kakamega RSUs

Nutrient source: 0, 4 g 10N:10P:10K, 4 & 8 kg FYM per plant

LHI: 0, 1, 2, 3 leaves per branch once per week

Nyeri pumpkins

Kakamega pumpkins

- Fertilizer type had a significant effect on leaf weight harvested in all the days of evaluation, including cumulative weight.
- The no fertilizer had significantly the lowest leaf weight, while 8 kg FYM had significantly the highest harvested leaf weight.

- Fertilizer source had an effect on number of fruits harvested in both sites.
- In both sites, 8 kg FYM had more fruits compared with the other nutrients.
- However this was not significantly different with 4 kg FYM in Nyeri.
- No fertilizer had significantly the lowest fruits harvested in both sites.

- Fertilizer type had effect on fruit weight in both sites.
- In both sites, FYM at 8 kg had more fruit weight compared with the other treatments.
- However this was not significantly different with FYM at 4 kg in Kakamega.
- The zero fertilizer had significantly the lowest fruits harvested in both sites.

- Leaf harvest intensity had a significant effect on leaf weight in both sites.
- The highest leaf weight was recorded for plants with three leaves harvested per branch in both sites.
- The control had significantly the lowest leaf weight.

- Leaf harvest intensity had a significant effect on number of fruit s harvested in both sites.
- In both sites, control had more fruits harvested compared with the other treatments.
- The 0 LHI had significantly highest fruits harvested in both sites.

- Leaf harvest intensity had a significant effect on fruit weight in both sites.

- In both sites, the 0 LHI had significantly more fruit weight compared with the other LHIs, while the 3 LHI had significantly the lowest fruit weight.

Conclusions

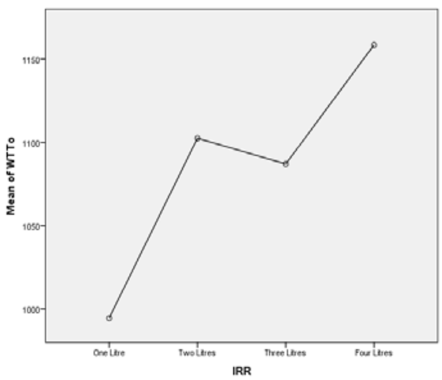
- FYM was superior to NPK
- 8 kg FYM was superior to all other nutrient levels
- Nutrient source effect on both leaves and fruits was significant
- 0 LHI = no leaf vegetables but highest fruits
- 3 LHI = highest leaf vegetables but lowest fruits
- LHI effect on both leaves and fruits was significant
- Sites (Nyeri and Kakamega) led to same conclusions

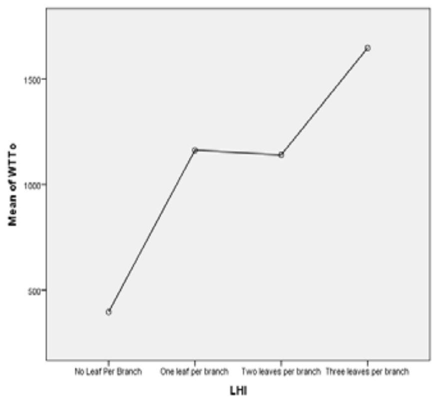
Subproject Title: Irrigation rate and leaf harvesting intensity effects on fruit, seed and leaf yields

Research Sites: KARI Embu and KARI Kabete
Irrigation rate: 1, 2, 3, 4 litres per plant once per week
Defoliation: 0, 1, 2, 3 leaves per branch once per week

Rain shelters such as these ones were used to keep out rain water

RESULTS
KARI-Embu
- Effects of irrigation rate (L) and LHI (R) were significant on leaf weight (g).
- 1 litre was the only one significantly different from the other litres.
- 0 LHI was the only one significantly different from the other LHI.

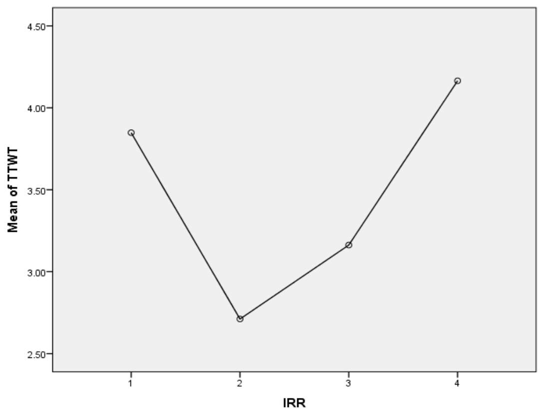


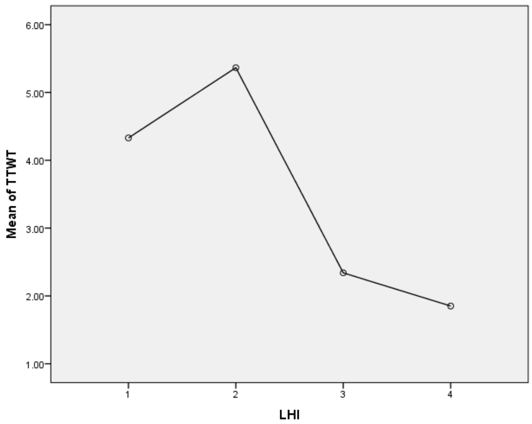


KARI-Kabete
- Effect of irrigation rate (L) NS and LHI (R) significant on leaf weight (g)
- Leaf weight increases with increase in irrigation rate & then declines
- 0 LHI was the only one significantly different from the other LHI

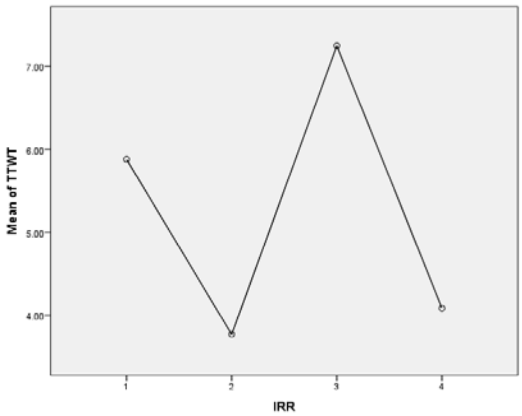
Results on leaf yield were as expected. Increase in irrigation rate & LHI increased leaf yields.

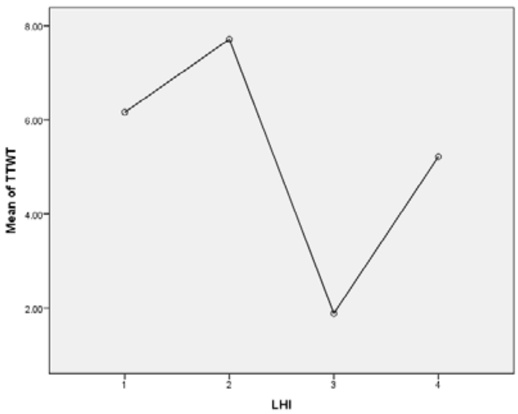
KARI-Embu
Effect of irrigation rate (L) NS and LHI (R) significant on fruit weight (kg)





KARI-Kabete
Effect of irrigation rate (L) NS and LHI (R) significant on fruit weight (kg)





Fruit harvesting is not complete.

Results of cumulative fruits might be as expected.

Fruit abortion affected treatments and cause(s) need(s) to be investigated.

Field Challenges

-Moles -Rain shelter expense. –Hailstones. -Powdery mildew. -Fruit abortion

OUTPUT 2: POSTHARVEST HANDLING, VALUE ADDITION & UTILIZATION OF PUMPKINS IMPROVED

2.1.2.2a Develop, evaluate and promote new bulk packaging technologies
2.2.2.1a Evaluate pumpkin dehydration methods and promote the best ones
2.3.2a Develop improved recipes for pumpkin

-Elaborated proposal is ready
-Experimentation to start this year
-Will work on produce transformation, blending, packaging, shelf-life, recipe development, nutrient content & integrity, income generated

Challenges
-Experiments are expensive
-Funds are inadequate

Planned activities for 2013
Output 1:
-Field evaluation of accessions
-Molecular charaterisation of accessions
-Participatory pure seed bulking and distribution
-Germplasm conservation at GBK
-Complete nutrient and water management experiments
-Data analysis and publication

Output 2:
-Embark on postharvest, value addition & recipe development experiments

Planned activities for 2014
Output 4:
-Transmission using different media
-Train stakeholders in optimal pumpkin agronomic practices, post-harvest handling, value addition and marketing strategies.
END