

# Prospects of mango fruit powder production at farm level and its utilisation during mango off-season in Ghana

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**Summary:** Mango (*Mangifera indica*) is an important fruit served to customers as fresh-cut fruit, juice, ice cream and yogurts in many fruit juice joints, restaurants and hotels in Ghana. However, the crop's highly seasonal and perishable nature is a challenge for food processors and farmers. Preservation of the fruit in dry particulate form can serve as a substitute in off-seasons. The study sought to determine mango fruit powder production prospects at the farm level and explore its potential use as a substitute during the off-season. Farmer groups and food enterprises were therefore interviewed. The study showed that Keitt and Kent varieties were the most cultivated varieties because of market demand and high yield. However, an average annual fruit loss of 29.8% at the farm level was observed. Postharvest extension delivery service to farmers is inadequate, and where available, frequency of contact is irregular. A limited number of farmers received training in fruit processing; and few were engaged in transformational value addition activities but were willing to add value through processing into powder. Probit regression analysis showed that a unit increase in training would increase transformational farm level value addition into mango fruit powder by 22.9%. The majority of the food enterprises source fruits within Ghana while 79% experienced mango fruit shortage in the off-seasons. Only a few of the enterprises used mango fruit-based substitutes to serve customers in off-seasons. Probit regression analysis showed that a marginal increase in processors' use of substitute significantly ( $p \leq 0.05$ ) increased willingness to use mango fruit powder as a substitute by 47%. The study has revealed that local production of mango fruit powder could serve as a substitute to fill the seasonal gap in mango supply and also reduce post-harvest losses.

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**Key words:** mango powder, post-harvest losses, substitute, training, value addition

## Introduction

Tropical fruits now constitute a comparatively emerging group in global commodity trade due to advances in transportation, trade agreements and the changing consumer preferences towards these fruits (Altendorf, 2017). Mango (*Mangifera indica*) is one of the important fruit crops. The pulp of mango fruit is a good source of micronutrients, including trace elements such as calcium, phosphorus, iron, and vitamins particularly vitamins A and C (Lebaka et al., 2021).

The fruit receives high patronage in Ghana; the third most consumed fresh juice after pineapple and oranges (Broek et al., 2016). Ghana has a comparative advantage of two production seasons in the Coastal Savannah zone (Nettey et al., 2016). The two mango production seasons comprise, the major season (April-August) and the minor season (November-January) (Ghana Investment Promotion Council (GIPC), 2018). The fruits are available as seasonal surpluses during these periods of the year in different growing areas.

Fresh mangoes are highly perishable (Srivastava et al., 2016) and that presents a challenge in terms of marketing or export as fresh produce over an extended period of time. Postharvest losses often occur both in the main and lean seasons. The estimated mean postharvest losses of mango fruits in Ghana in the major and minor seasons are 60.5% and 36% respectively (Food and Agriculture Organization, 2011). Secondly, the highly seasonal nature of mango is a major

constraint to both farmers and fruit processors. Glut brings down market price and sometimes lack market because the few agro-processors are unable to utilize the large quantities of mangoes produced, reducing farmers' income in the main harvest season. On the other hand, processors are stranded in production in the off and minor seasons because of lack or inadequate mango fruits (Business & Financial Times, 2017). There is the need therefore to preserve the excess supply of the produce to feed processing industries during off-seasons. The objective of this study was to investigate the prospects of mango fruit powder production at the farm level and potential utilization in the off-seasons by food enterprises processing and vending fresh mango products in the Greater Accra Region of Ghana.

## Materials and methods

### *Study area, design and data collection*

Two different surveys were conducted at the mango farmer and processor levels between October 2018 and December 2018. All the data collection for the two surveys was done physically on site and in person. At the farm level a survey was conducted on sixty-six (66) purposely selected members of

three mango farmers' groups in three districts of the Eastern region of Ghana using a questionnaire. The districts included Shai-Osudoku, Yilo Krobo and Lower Manya Krobo and were selected because they are among the major mango cultivation areas in Ghana. The questionnaire was designed to obtain information on socio-demographic characteristics and production activities; availability of production and postharvest services as well as postharvest operations including farm level value addition.

At the processor level, the survey was conducted in the Greater Accra Region of Ghana. The area was chosen for this study due the large number of restaurants, fruit juice joints and fruit processing industries. The food-based enterprises that utilize fresh mango fruit, comprising of restaurant operators, fruit juice joints and fruit processing factories were identified. Thirty-eight enterprises willing to participate were randomly selected and interviewed using structured questionnaire. Information obtained included brief company profile, fresh mango fruit utilization, sourcing, fluctuation in supply and mango fruit-based substitutes utilization and willingness to use mango powder. The data from the two surveys was done physically on site and in person were subjected to statistical analysis using Stata 14 (Stata Corp. USA). Associations among variables were tested at  $p \leq 0.05$  and results presented in tables and figures.

## Results

### *Socio-demographic characteristics, production and postharvest activities of mango farmers*

Mango production in the study area is male dominated (97%) and most of the farmers (62.2%) are aged 46 years and above while 37.8% are between bracket of 18-45 years (**Table 1**). Literacy level is high (95.5%) among the farmers with considerable number (39.4%) having acquired tertiary education. Majority (54.5%) of them have more than 10 years experience in mango farming with farm size up to 8 hectares (78.8%). The farmers mostly (53%) cultivate a mixture of Keitt and Kent varieties and the average annual losses is 29.8%. A significant number of farmers (60.6%) receive production extension delivery services though not satisfactory, which is mostly provided by NGO's (47.5%), Access to postharvest extension delivery services is significantly lower (45.5%). All the farmers undertake at least one non-transformational value addition activity, which include sorting, counting, weighing, packaging in crates and transporting. However, only 18.2% are involved in both non-transformational and transformational value addition activities. Few of the farmers (34.6%) have received training in mango fruit processing however, 95.5% of them are willing to add value to their produce through mango fruit powder production (**Table 1**).

### *Effect of farmer characteristics and farm operations on farm level value addition activity*

Generally, education, years of farming, farm size and access to credit have no significant effect on value addition activity of the farmers. However, training in processing had significant ( $p < 0.05$ ) effect on value addition. A unit increase in training caused an increase in farm value addition by 22.93% (**Table 2**).

**Table 1.** Socio-demographic characteristics and farm activities of mango farmers (n=66).

Characteristic	Category	Percentage
Gender	Male	97
	Female	3
Age (years)	18-25	3.0
	26-35	15.2
	36-45	19.6
	46-55	15.2
	56-65	31.8
	>65	15.2
Educational background	Non-formal	1.5
	Primary	4.5
	MSLC	28.8
	JHS	7.6
	SHS	18.2
	Tertiary	39.4
Years of mango farming	<5	13.6
	6-10	31.8
	>10	54.5
Farm size (Hectares)	<4	37.9
	4-8	40.9
	>8	21.2
Variety cultivated	Keitt	22.7
	Kent	7.6
	Keitt + Kent	53.0
	Keitt + Kent +Other	16.7
Annual average losses	Losses	29.8
Access to production extension services	Yes	60.6
	No	39.4
Source of production extension service	AEAs	35
	NGOs	47.5
	Peers	17.5
Access to postharvest extension services	Yes	45.5
	No	54.5
Source of postharvest extension service	AEAs	6.7
	NGOs	66.7
	Peers	26.6
Value addition activity	Transformational	18.2
	Non-transformational	81.2
Training in fruit processing	Yes	36.4
	No	63.6
Willingness to add value through powder processing	Yes	95.5
	No	4.5

\*MSLC: Middle School leaving Certificate; JHS: Junior High School; SHS: Senior High School; AEAs: Agricultural Extension Agents

### *Profile of the food enterprises, mango fruit supply and fruit powder utilization prospects*

The respondents mostly comprised of managers (65%) and supervisors (13%) with 76% of the enterprises employing up to 20 workers. Majority (84%) had been in operation for less than 5 years (65.8%) producing mostly to serve the local consumer market (94%) (**Table 3**). The fruits were mostly (97%) sourced within Ghana from retailers (68.4%) and farmers (28.9%). Majority (89.5%) utilized less than 30 kg daily to serve customers and 78.9% experienced mango fruit shortage at certain times of the year however, 86.8% did not use mango fruit-based substitute in the off and lean mango season. Few (34.2%) of the enterprises were willing to utilize mango fruit powder as substitute (**Table 3**).

**Table 2.** Marginal effects of the probit regression for determinants of transformational value addition activity at the farm level.

Variable	Marginal effect	Std. err	z	P> z	95% Conf.	Interval
Education	0.0156	0.0325	-0.48	0.631	-0.0793	0.0480
Years of farming	0.0509	0.0649	0.78	0.433	-0.0763	0.1781
Farm size	0.0655	0.0631	-1.04	0.299	-0.1892	0.0580
Credit	0.1163	0.1409	0.83	0.409	-0.1598	0.3925
Training in Processing	0.2293	0.0757	3.03	0.002*	0.0809	0.3778

\*Significant at 5% level

**Table 3.** Profile of food enterprises, fresh fruit supply and fruit powder utilization.

Characteristic	Category	Percentage
Position of respondent	Manager	65.8
	Owner	5.3
	Salesperson	7.9
	Supervisor	13.2
	Accountant	7.9
Staff strength	<10	44.7
	10-20	31.6
	>20	23.7
Years of business operation	<5 years	65.8
	5-10 years	18.4
	>10 years	15.8
Product market destination	Domestic market	94.7
	Domestic + Export	5.3
Sources of fruits	Retailers	68.4
	Farmers	28.9
	Wholesalers	2.7
Volume of fruits utilized daily	<30 kg	89.5
	30-60 kg	2.6
	>60 kg	7.9
Fruit shortage in supply	Yes	78.9
	No	21.1
Period of shortage	Off-season months	71.1
	No shortage	21.1
	Lean season months	7.8
Use of substitute	Yes	13.2
	No	86.8
Willingness to use mango powder as substitute	Yes	34.2
	No	65.8

**Table 4.** Estimated coefficients and marginal effects on processors' willingness to use mango fruit powder as substitute.

Dependent Variable: Willingness to use mango fruit powder (1 = Willing, 0 = Not Willing)				
Explanatory Variable	Probit			
	Coefficient	P> z	Marginal Effects	P> z
Years of operation	0.0929	0.748	0.0300	0.747
Volume of fruits utilized daily	0.0278	0.887	0.0090	0.887
Fluctuations in fruit supply	0.1188	0.827	0.0384	0.827
Use of substitute	1.4687	0.032*	0.4758	0.008*
Constant	-0.9315	0.257		

Number of obs.= 38  
 LR chi2(3) = 5.34  
 Prob > chi2 = 0.2539  
 Pseudo R<sup>2</sup> = 0.1094  
 Log likelihood = -21.7404

\*Significant at 5% level

### ***Determinants of mango fruit-based substitutes utilization and mango fruit powder potential***

From the probit regression analysis, use of mango fruit-based substitute significantly ( $p < 0.05$ ) and positively influenced processors' willingness to use mango powder as substitute. Marginal increase in processors' use of substitute significantly increased their willingness to use mango fruit powder as substitute by 47.6% (**Table 4**). Years of business operation, volume of fruits utilized daily and fluctuations in fruit supply had positive influence. The marginal effects indicated that increases in years of operation, volume of fruits utilized daily and fluctuations in fruit supply contributed to increase in processors' willingness to use mango fruit powder as substitute by 3%, 0.9% and 3.8% respectively though not statistically significant but of substantive and practical significance (**Table 4**).

### **Discussion**

Mango production in the study area was dominated by males who were mostly middle-aged or older. This might be due to resource intensive nature of mango farming, in terms of land acquisition and financing, and these are not readily available to women and the youth. Generally Ghanaian women lack high initial capital and the labour required for tree crop production (Wrigley-Asante et al., 2019) and according to Nyantakyi-Frimpong (2020) few women owned lands with secured tenure. Tunde & Tilakasiri (2020) also indicated that only 8% of women farmers are able to own farmland through purchase, as land ownership is predominantly by inheritance.

There was high literacy level among the farmers with a remarkable proportion having had tertiary education. Similar observations had been made in the educational demography of farmers in the Shai-Osudoku district in Ghana by Okorley et al. (2014). Educated government workers and literate individuals in Ghana venture into tree crop production as supplementary income, and those who go on retirement, invest retirement benefits in commercial farming activity (White, 2013). This ensures a regular supply of income to support themselves and their families after being taken off government payroll and in their old age.

Most of the farmers had considerable years of experience in mango farming. They owned farms that were more than a decade old and cultivated on different farm sizes ranging from small to medium to large scale, Okorley et al. (2014) however, reported that the mango farmers mostly engage in small scale production in the area. The comparatively larger farm size observed in this study might be due to farm expansions over the past few years. The common mango varieties grown were a mix of Keitt and Kent and other varieties such as Palmer and Haden. The mix was to satisfy different market demands to increase income as these were highly demanded by processors and the freshcut market. These exotic varieties, which are characterized less fibrous, high in pulp content coupled with good quality taste and flavour, are more preferable to consumers. Operators of restaurants, hotels and supermarkets put premium on fruit colour, size, freshness and firmness (Diamini-Mazubuko, 2020).

The average annual loss of 29.8% is considerably higher than the 16.3% reported by Boateng (2016). The farmers' access to credit was significantly low, on the other hand, labour was readily available to the farmers. The lack of credit

facilities might be due to the risk associated with most smallholder farms. Some of the risks include irregular weather patterns, pests and diseases, which affect yield and unstable markets (IFPRI, 2010). These factors make smallholder farmer lending a risky venture. Collateral requirement by financial institutions has been reported to be a major constraint for farmers to access credit (Adams, 2015). According to Donkor (2018), access to financial credit has a significant positive contribution to farmer participation in the cassava processing industry, as financial resources are crucial for the purchase of processing equipment and the payment for the various processing operations. Providing the necessary credit to farmers will therefore improve farm level participation in value addition to increase farmers' income.

Access to production extension delivery services was not satisfactory and was mostly provided by NGOs with frequency of contact also being irregular and inadequate. Apart from the low national farmer-extension agent ratio, the situation is compounded by lack of logistics, inadequate continuous training and incentives for the government's agricultural extension agents (AEAs) (Peasant Farmers Association of Ghana, 2016). These had resulted in scarce, demoralized and unproductive agricultural extension agents, which affected the delivery of effective extension services to farmers. This is a huge setback on mango farm production business, which supports rural livelihood. This study has revealed that currently, the delivery of extension services is mainly done by NGOs, but it is still far below the requirement and expectation in terms of number of farmers needing extension delivery services.

In the case of postharvest extension service delivery, a large number of the farmers had no access and where accessible, it was mainly also provided by NGOs. This might be due to limited attention given to training in postharvest technology as compared to production technology. Furthermore, little emphasis is placed on the transformational value addition aspect of postharvest technology and therefore farmers lack the requisite training and skills. Minimum funding had, over decades, been apportioned to postharvest issues as the focus had been on production expansions and yield increases (Oino, 2017) and that only one-third of the allotted 1% for horticultural projects of agriculture in developing countries had a postharvest component (Kitinoja et al., 2011).

Farm level value addition to mango, in the perspective of this study, is described as carrying out at least one of the transformational and or non-transformational value addition activities. The farmers undertook at least one non-transformational value addition activity, which included sorting, counting, weighing, packaging in crates and transporting. But, only 18.2% were involved in on-farm transformational value addition activities. According to Orinda (2013) and Adeyonu et al. (2016), farmers who have had entrepreneurial training on agricultural value addition through hands-on seminars and workshops had more exposure on the importance of farm level value addition with a direct association between the farmer level value addition training and the farmer's decision to add value to sweet potato. Value-added products offer variety to farm operations, create new markets and niche, increase brand recognition and subsequently offer higher returns to the farmer (Nikol & Jansen, 2021). Also, producers engaged in value addition activities have competitive advantage over others (Chege, 2012). In order to transform the livelihoods of rural smallholder farmers, the need may arise to improve the quality

of farm products (Devaux et al., 2018). This can be achieved through access to the required knowledge, skills and the introduction of improved postharvest practices, which may include farm level produce processing.

The marginal effects of the probit model measured the actual effect of a unity change in the explanatory variables on the dependable variable. It was observed that among all the explanatory variables employed (education, years of mango farming, farm size, credit and training in processing), only training in processing had a significant influence on the farmers' willingness to add value through mango fruit powder processing. A unit increase in training or knowledge and skill acquisition in fruit processing significantly increased farmers' willingness to process produce into other products. This demonstrates that there is great potential for mango fruit processing at the farmer level, if farmers are given the required training. This will reduce the losses experienced at harvest and maximize farm output by channeling the excess supply of fruits in the main season to other valuable farm products to increase farm income. Value addition contributes significantly to income and employment, which culminates into the advancement of other monetary ventures in the rural economy (Sarku, 2014). An increase in the training of mango farmers in southern Ghana decreased farm level postharvest losses by 8.4% (Boateng, 2016).

Continuous postharvest extension service delivery particularly in processing, will further build the farmers' capacity to transform excess produce to more valuable products for postharvest loss prevention and increased income. A number of modern mango processing technologies are available, but are often restricted to the large-scale commercial industry players; and are not conventionally employed at the farm level by many mango farmers in Ghana. These processing technologies include pulping, juicing and jam making; drying into chips, leathers, powder and fermentation into wine and can be achieved through techniques simple to acquire, practice and operate with appropriate equipment. Farm level training in simple processing technologies can contribute immensely to contain the seasonal excess supply of mango fruits, prevent postharvest losses and ultimately increase farm income through diversified products and markets (Gitonga et al., 2014).

The profile of the food businesses showed that persons other than the owners managed most of the businesses. This observation might be due to the fact that the high cost of renting premises in Greater Accra and its environs made it impossible for businesspersons with low capital to engage in the industry. Prices of properties and rent in the urban centers such as Accra, Tema, Kumasi and Takoradi are high because of accelerated urbanization and a rapid growing middle-class (Gaisie et al., 2019). More financially endowed businesspersons are therefore involved and managers and supervisors are then hired to run the day-to-day operations of the enterprises.

Products of most of the businesses were mostly for the domestic market; the businesses had few staff and had been in operation for less than five years. Small-scale enterprises in Ghana have been described either based on the number of staff employed or based on the capital requirements for the establishment of the enterprise (Peprah et al., 2016) and that according to Owusu-Acquah & Nguah (2016) small scale manufacturing units may have workers not exceeding thirty (30) people. The few working force among the food enterprises might be due to the fact that small enterprises require few hires until the business expands, which may take a considerable period of time.

Majority of the enterprises utilized the exotic variety of fresh mango fruits cultivated locally for the preparation of juices, yoghurts and ice creams to serve their customers. The preference for the exotic varieties might be due to their high pulp content, rich flavour, taste, aroma and economic profitability. High pulp content and rich flavour have been reported as the reasons the exotic varieties were the most preferred by the fresh market, consumers and processors in Ghana (Zakari, 2012).

The volume of fruits utilized daily was mostly less than thirty kilogrammes (30 kg), which might be due to the nature of the businesses being small-scale. However, fluctuations in mango supply as a result of the highly seasonal nature of the produce were observed. The mango off-season period largely occurred from March-to-April and then from August-to-November as reported by GIPC (2018) that fruits were available in May-to-July (main season) and then from December-to-February (minor season). In the main season, fruits were in abundance whereas inadequate and lack of fruits characterized the lean and off-seasons respectively. The fluctuations affect prices for both farmers and processors resulting particularly for the farmer uncertainty of income within the year. According to Business & Financial Times (2017) while there was glut resulting in low produce price in the main season at the farmer level, processors were stranded in production in the off-season months. However, very few of the processors utilized mango fruit-based substitute particularly mango fruit powder during the off-season citing its unavailability and uncertainty of mango fruit powder substitute because of colour and flavour concerns. Consumer acceptance of substituted products, specified as substitutes-in-use, is affected by attribute concerns, as the substitute must serve a similar purpose as the original substance (Mehta & Agrawal, 2020). Therefore the concerns raised must be adequately addressed in the development of mango fruit powder in Ghana.

The estimated marginal effects of the contributory factors to processors' willingness to use mango fruit powder as substitute showed that years of operation and fluctuations in fruit supply had positive but not significant marginal effect. However, use of substituted products had significant marginal effect on processors' willingness to use mango fruit powder as a substitute. The study found that a unit increase in the use of a substitute would cause an increase in the processors' willingness to use mango powder as a substituted product by 47%. That is, the use of substitutes in the off-season is more likely to increase processors' use of mango powder as a replacement when the mango season is over. Therefore the development of good quality mango fruit powder product has a great potential of being used as a substitute when fresh fruits are out of season.

## Conclusions

The study has revealed that increase in farmer level training will favour transformational value addition particularly mango fruit powder processing to reduce postharvest losses, increase farmer income and improve rural livelihood. Food enterprises processing and vending fresh mango products in the Greater Accra Region of Ghana experienced fruit shortage in the off-season. However, few of the enterprises utilized mango fruit-based substitute particularly mango fruit powder. Effort should therefore be targeted at development of high quality mango fruit powder that imparts acceptable sensorial attributes to satisfy the expectations of the potential users.

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