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Full Length Research Paper

Green Tea Processing in Nigeria and its Economic Implications

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In this study, attempt was made to process Green Tea using local processing Technology as recommended by the Chinese method. Fresh tea leaves were plucked, fixed, rolled and dried under the sun. Physical and Chemical analysis of the processed green tea were carried out using standard methods. Economic Analysis of the Green Tea were also carried out using the method involving Investment Decision model comprising Net Present Value (NPV), Benefit-Cost Ratio (BCR) and internal Rate of Return (IRR). Our results showed that the green tea produced conformed to ISO standard for good quality Green Tea. The range of moisture content was 4.11-7.00%, Crude Fibre (4.37-20%), water extracts (21.7-43.6%) and the caffeine in the range of 1.00 - 1.29%. The economic Analysis carried out indicated the profitability as shown in the values of the NPV, IRR, and BCR which were N13,928,856.02, 27.19% and 2.25 respectivelyIn conclusion, the diversification into Green Tea processing will create a new opening for tea farmer who has hitherto relied on more capital intensive black tea processing with lesser profitability.

Keywords: Green Tea, Investment decisions, Benefit cost ratio, Net present value, IRR

INTRODUCTION

Tea is made from the young tender shoots (flushes) of *Camellia sinensis* (L) O. Kuntze Hara-Kude et al., 2005) and is the most consumed drink after water, due to its refreshing and mildly stimulating effects (Harbowy and Balentine, 1997). Tea is an aqueous infusion of dried leaves of the plant *Camellia sinensis*. Tea is a dietary source of antioxidant nutrients such as carotenoids, tocopherols, ascorbic acids and non nutrient phytochemicals generally classified as flavonoids and also regarded as safe for consumption by the USFDA (Wu et al., 2002. It is reported that tea extracts inhibit human salivary amylase (Zhang and Kashket, 1998) and disturb digestion and nutrition. Numerous studies have demonstrated that aqueous extracts of black and green tea possess antimutagenic, anti-inflammatory, hypocholesterolemic, antibacterial, antidiabetic (Hamilton-Miller, 1995), anti-tumour, (Mtscher *et al*., 1997) anti-UV-induced oxidative damage (Wei et al., 1999), anti cariogenic (Wu and Win, 2002) activities in a variety of experimental animals systems. Teas are usually classified as black, green, Oolong, Yellow, white and dark compressed tea . Concerning antioxidant therapy, green tea appears to be a promising candidate. Green tea is the first beverage consumed worldwide. It is very popular in Asia where it has been known for centuries as a healthy beverage. Green Tea has been examined intensively over the past 20 years for its

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medicinal properties (Higdon and Fri, 2003, Nakashi *et al*., 2003). These include its potential as an antioxidant (Higdon and Frei, 2003, Nakagawa et al, 2004), anticancer (Hong *et al*, 2000), anti-inflammatory (Dora et al, 2003), antibacterial , antiviral (Fassina *et al.,* 2003), antifibrotic , hypolipidemic (Yeh *et al*., 2003) or cardioproptective agent. . In addition, green tea has been shown to protect the brain (Hong et al., 2000, Suzuki et al, 2004) and heart from ischemia-reperfusion –induced damage. Finally, it modulates cellular Ca^{2+} handling. In Nigeria, the [production of black tea is done on the Mambilla Highland at about 145om above mean sea level where the raw material (fresh tea leaves) for the black tea processing is found. The processing factory , located on the Mambilla Highland, Nigeria (Nigeria Beverage Production Company) relies on tea leaves supplied buy farmers to process their black tea. Unfortunately, the quantity of fresh tea leaves supplied by framers out weighed the quantity the processing capacity of the old fashioned Lawrie tea processor available at the Company. As a result , tea leaves supplied by farmers could not be utilized leading to owing of farmers the monies for their tea leaves. This leads to wastages and frustrations for tea farmers whose hope is on the tea factory. Since supply of tea leaves tea is no more lucrative, farmers sought for alternative way of living by converting their tea farms to other crops like maize and vegetables. Other farmers who could not do this started to produce black tea through local and unhygienic method of pounding, fermentation and drying in the Sun. Despite this unhygienic way of producing green tea, , farmers were still selling the black tea to other neighboring countries ;like Sudan, Niger and Cameroun. This development resulted in an unhealthy rivalry between the farmers and the tea factory as regulatory agents are invited to prosecute the farmers who could not afford the state to art machines like CTC to manufacture their teas and who could not form a cooperative to procure such expensive equipment like the CTC machine to produce their teas. This development necessitated the shift from the regular black tea to green tea , the technology of which is simpler than black tea and requires limited use of big machines. This study , however is designed to produce green tea using the local processing Technology of the Chinese, the owner of green tea, examine its chemical qualities and its economic viability.

For a viable production process, the economic implication has to be taken into consideration to ensure profit margin. This study therefore reports the production and economic analyses of green tea production in Mambilla Plateau of Nigeria.

METHODOLOGY

Materials and Methods

Green tea samples used in this study were processed in triplicates . The tea samples were obtained from the highland of Mambilla,Taraba State, Nigeria. The fresh tea leaves used in the green tea production were plucked from vegetative propagated (VP) tea fields at the Cocoa Research Institute of Nigeria (CRIN) substation, Kusuku, Mambilla located around 1450m above mean sea level, latitude 16^{o}N and longitude 37 56^{0}E. The plants were grown under recommended agronomic conditions. The tea were plucked at the tea plantation and processed by the miniature green tea processing facilities. The plucked tealeaves were withered shortly followed by fixing to inactivate the activities of the polyphenol oxidase enzyme using the Chinese methods of Pan fixing. The pan-fixed leaves were later rolled and dried using Sunlight. . The green tea produced were later packaged in paper board boxes and reserved for Analysis

Preparation of the Tea Solution.

The Tea preparations consisted of addition of boiling water (200ml) to leaf tea (2g), then the tea solution was filtered through cotton wool and the residue was washed with distilled water (30x10ml). The tea solution was cooled to room temperature and washings were diluted 250ml with distilled water. The samples were analyzed in triplicate.

Caffeine and water extracts

The methods used for the Analyses of caffeine and water extracts of the tea solution were based on international standards (ISO 1539), 1980; (ISO 9768, 1994); Yao *et al.,* 1993 as stated below:

Caffeine

Lead Acetate solution $(CH_3COO)_2Pb$
100g was dissolved and diluted to 200ml with distilled water.
Hydrochloric acid solution, HCl
36%, specific gravity, 1.18, 0.9ml was diluted to 100ml with distilled water
Sulphuric acid solution
Sulphuric acid (98%) H_2SO_4, specific gravity, 1.84,

Table 1: Chemical Composition of Green Tea processed from Nigeria

Chemical parameters	Sample	ISO standard
% water extracts	42	Minimum 32
% Total Ash	6.3	Maximum 8 Minimum 4
% water soluble ash	67	Minimum 45
% Acid insoluble ash	0	Maximum 1.0
Alkaline insoluble ash	0.90	Maximum 3.0 Minimum 1.0
% Crude Fibre	4.37	Maximum 16.5
% Moisture content	4.1	Maximum 6.5
% Caffeine	2.39	-

16.7ml) was diluted to 100ml with distilled water.

Measurements: Tea solution (10ml), HCl (5ml) and Lead acetate solution (1ml) were mixed in a 100ml volumetric flask and diluted with distilled water. The solution was then filtered through whatman No1 quantitative filter paper. The filtrate (25ml) and sulphuric acid solution (0.3ml) were placed in a volumetric flask and diluted to 50ml with distilled water. The solution was filtered using the same type of filter paper. The absorbance of the filtrate was measured using Ultraspec III UV /visible spectrophotometer at 274nm. The measurement was performed in triplicates.

Standard Curve

Caffeine stock solution (10ml), 1mg/ml, w/v in distilled water was diluted to 200ml with distilled water. Next, 0,10,20,30,40, or 50 ml of the diluted caffeine solution were separately mixed, each with Hydrochloric acid solution (4ml) in a volumetric flask are diluted to 100ml with distilled water. Thereafter, the remaining steps were repeated as described earlier. The readings of the standard solution against the concentrations were used to prepare the standard curve

Calculation

Caffeine (%))= $E/1000 \times V_0 \times (100/V_1) \times (50/25)/W = 0.2EV_0/V_1/W$

where E is ' mg' of caffeine from the standard curve against the reading of the spectrophotometer and E/1000 is to convert 'mg' into 'g'. V_0 is the total volume of the tea solution (250ml); V_1 is the volume used for the measurements (10ml), and 100/V1 indicates 10ml tea solutions that were diluted to 100ml, while 50/25 shows that another dilution from 25ml tea filtrate made to 50ml in the measurement. W is the dry weight of the tea sample.

Water Extracts

Measurements

Tea solution (50ml) was placed in a weighed evaporating dish and was then evaporated to dryness over a water bath. The residue (tea extracts) in the dish was fully dried in a vacuum oven at 75^{O}C with a negative pressure of 65kPa for 4h until the weight of the dish with extract was constant.

Calculation

Water extract (%) = $(D_1-D_0) \times V_0 \times 100/V_1/W$

Where D_1 is the weight of the dry tea extracts with the dish; D_0, is the weight of the dish, V_0 is the total volume of the tea solution (250ml), V_1 is the volume used for the Analysis (50ml); W is the dry weight of the tea sample Moisture Content.

The tea moisture was measured using a vacuum oven based on an international standard method ISO 1573, BS 6049-2, 1984.

Economic Analysis

In carrying out the economic evaluation of green tea, data on variable and fixed cost as well as expected revenues were collected as shown in table 1. The fixed cost appears to be small and this is due to the fact that the technology employed is a very simple one that requires no high capital overlay. From this cost items, a stream of discounted cost and benefit were calculated base on the opportunity cost of capital or discount rate of 21% and 32%.

The results were subjected to investment decision model such as net present value (NPV), Benefit- cost Ratio (BCR) and internal rate of returns (IRR) on

Table 2. Crude Fibre (g/100g) of Tea from different Countries

Countries	N	Range	x ± sd
China	10	10.96-12.92	11.49±0.89
India	12	9.56-27.89	15.24±7.91
Malawi	12	5.83-43.27	21.08±15.7
Sample	3	4.37	

investment.

The Investment Decision Model.

Net present value (NPV)

The net present value is an important tool in making decision by an entrepreneurs investing in green tea production. In arriving at the NPV, the stream of discounted cost and benefit were used to obtain the net income (NI) for each year.

Following Gotsch and Burger (2001) model, if we define NI as the net income (or benefit) from one year production of green tea as expected in year t, then the net present value of the expected net income from production circle will amount to:

$$NPV_{I,t.} = \sum_{i=1}^{I} \frac{INC_{i,t}}{(1 + r)^i}$$

$INC_{i,t.}$ is the expected net income of production in year t given as:

$$INC_t = \sum_{i=1}^{I} (REV_{i,t} - TC_{i,t})$$

Where $REV_{i,t}$ is the expected revenue from the green tea production in year t

TC is the total cost of production in year t and

r is the discount rate or the opportunity cost of capital and t is the time period.

In arriving at a conclusion, the criterion selection is to accept the investment of green tea production as technically and economically visible if the net present value is positive. However if NPV is negative it implies that the stream of discounted income or benefit ($REV_{i,t}$) is less than the discounted cost ($TC_{i,t}$) . The implication of this is that the revenues are insufficient to allow for the recovery of the investment.

Benefit Cost Ratio (BCR)

The investment Decision model also utilizes the Benefit - Cost Ratio (BCR). It is given as the ratio of the sum of discounted benefit to the sun of discounted cost. Thus for a cycle of *1* year duration, the benefit cost ratio is expressed as follow:

$$BCR_{i,t} = \sum_{I=0}^{I} \frac{DREV_{i,t}}{DTC_{i,t}}$$

where $DREV_{i,t}$ is discounted revenue from green tea production in year t

$DTC_{i,t}$ is the discounted total cost of green tea production in year t.

According to Gittinger, 1989, the decision rule is that for an investment to be economically viable, the ratio must be greater than unity. In this green tea economic investigation process, the following basic assumptions were made: Fixed cost remains constant for the 5 year period, variable cost increases by 10% yearly, output increases by 10% yearly, selling price is constant. Contingency was taken to be 5%, 36,000 pouches of made tea produced per year and selling price was N200 per pouche

RESULTS AND DISCUSSION

The water extrcats found in this study was higher than the minimum water extract recommended by the ISO standard which shows that the material in our study is of good quality internatioanal accepytablity (ISO, 3720, 1986).

The waterv extrcs of the green tea processed in our study is higher than those reporteineed by Liu *et al.,* 2006 who reported 39.18% in six green tea bags from Australian Market.

Moisture contents: The moisture ocntent is a good index of good storage as moulds growth is enhanced by high humdity. The moisture cionten recorded in our study (table 1) is about 4.11% which is in comformity with the reporrts of Tea Reaserchers like Othieno and Owuor, 1984; Robinson and Owuor, 1993 who suggested that the moisture content of the teas shoulsd be controlled to lie under 6.5% for marketing tea.

The caffeine obtained in this study was within the recommended ISO standard. Caffeine is ereponsible for the stimulating effects of green tea. Less than 300mg intake per day is not harmful for adults, but an intake of more than 500mg has been shown to cause excessive excitation in the centtral nervous system and cause arrythmia and vertigo (Paspa and Vassaila, 1984). As for water extrcts (WSE) , ISO 9768, recommends minimum of 3%. The green tea produced in Nigeria was within this

Table 3. Summary of Gross Margin Analysis of Green Tea Production

	Year 1	Year 2	Year 3	Year 4	Year 5
Fixed Cost	350,000	-	-	-	-
Variable Cost	2,966,400	3,263,040	3,589,344	3,948,278	4,343,106.24
Contigency5%	148,320	163,152	179,467.2	197,413.9	217,155.31
Total Cost	3,464,720	3,426,192	3,768,811.2	4,145,691.9	4,560,261.53
Output10%	36,000	39,600	43,560	47,916	52,707.6
Unit Cost	96.24	86.52	86.52	86.52	86.52
Selling price	200	200	200	200	200
Revenue	7,200,000	7,920,000	8,712,000	9,583,200	10,541,520
Net Income	3,735,580	4,493,808	4,943,188.8	5,437,508.1	5,981,258.45

Source: Computed values

Table 4. Cost, Return and Profitability of Green tea

Year	Cost	Benefit	Incremental Benefit	Discount Factor @ 21%	Discounted Cost	Discounted Benefit	NPV@21%	Discount factor @ 32%	NPV@32%
1	3,464,720	7,200,00	3,735,280	0.826	2,861,858.7	5,947,200	3,223,546.6	0.758	2,831,342.
2	3,426,192	7,920,00	4,493,808	0.683	2,340,089.1	5,409,360	3,069,270.8	0.574	2,579,445.
3	3,768,811.	8,712,00	4,943,188.	-0.564	2,125,609.5	4,913,568	2,787,958.4	0.435	2,150,287.
4	4,145,691.	9,583,20	5,437,508.	-0.467	1,936,036.1	4,475,354.	2,539,316.2	0.329	1,788,940.
5	4,560,261.	10,541,5	5,981,258.	-0.386	1,760,260.	4,069,026.	2,308,765.7	0.250	1,495,314.
Total					11,083,856.	24,814,50	13,928,858.		10,845,32

Source: Computed Values

limit as its value falls within 42%. The total ash of our sample was above the minimum level as proposed by the ISO standard which stipulated 8 as the maximum and 4 as the minimum. The sample used in this study is of good quality in ash content. The water soluble ash (WSA) of the tea was within the recommended ISO 1576 satndard, minimum=45%. Acid insoulble ash (AIA) of our sample was also adequate and conmformed to ISO 5998.

Measurement of crude fibre has been considered to be necessary to describe good quality green tea. The crude fibre of the green tea processed in this study (table, 2) is in accordance with ISO standard and lower than the crude fibtrre reported for Malawi tea. The geographical locations of processing area and the climatic factors might have played a very significant role. The significant differences ($p<0.05$) in the crude fibre as compared to Malawi is an indication that Nigerian tea is better than Malawi tea in crude fibre. Although, the sample from Malawi was black tea but there seemed to be no diference in the crude fibre value of grren and black tea according to the ISO standasrd. Smiechowska and Przemyslaw, 2006, descirbe tea age as a cotributory factor to crude fibre. The younger the tea leaves used to process the green tea, the lower is the fibre content.

Moisture Content: The moisture content is a good index of good storage as moulds growth is enhanced by high humidity. The moisture content recorded in our study is about 4.11% which is in conformity with the reports of Tea reaserchers like Othieno and Owuor; and Robinson and Owuor, 1993) who suggested that the moisture content of teas should be controlled to lie under 6.5% for marketing of tea.

Caffeine content: The caffeine content in this study was within the recommended ISO standard. Caffeine is responsible for the stimulating effects of green tea. Less than 300mg intake per day is not harmful for adults, but an inatke of more than 500mg has been shwon to cause excessive excitation in the central nervous system and cause arrythmia and vertigo (Paspa and Vassaila, 1984).

Water Extracts

As for water extracts, (WSE), ISO, 9768, recommends minimum of 32%. The water extracts of the green tea processed in our study is hihger than those reporetd by Liu et al., 2006 who reported 39.18% in six green tea bags from Australian Market.. Howver, the water extracts obtained in this study was within the ISO limit as the values were higher than the minimum recommended.

Total Ash

The total Ash of our sample was above the minimum level as proposed by the ISO standard which stipulated 8 as the maximum and 4 as minimum. The sample used in this study is of good quality in ash content.

Water Soluble Ash

The water soluble ash (WSA) of the tea was woithin the recommdation of the ISO standard 1576, for tea which stipulated minimum of 45%. Acid insoluble ash (AIA)

also fell within ISO 5998.

Economic Implications of Green Tea Processing

Table 3 showed the production cost of green tea to be N3,464,720.00 with fixed cost of N350,000.00. Variable /operating cost and contingency fund being N2, 966,400.00 and N148,320.00 respectively in the first year. Total cost was adjusted with an annual 10% year incremental rate to capture inflationary dynamics that may occur in subsequent years. A total of 36,000 pouches of made tea were produced in the year from 24 rounds of 1,500 pouches per round at #200 was used to estimate the project revenue The production process involved the use of one skilled and three unskilled labors. The BCR calculated (table 4) was found to be 2.25 implying that N2.25 would be earned per every N1.00 invested in the project while NPV discounted at 21% was ₦13, 928,858.00 as found in table 4 .The internal rate of returns was found to be 27.19%, meaning that the project has a higher earning capacity than the prevailing cost of capital (interest rate) that may be ploughed into the enterprise. The Three investment parameters used {NPV, BCR and IRR) are all positive. Hence, it can be concluded that the green tea production is economically viable and a worthwhile investment.

CONCLUSION

The study on the economic viability of the production of green tea revealed that it is a profitable investment and worthwhile embarking upon by would- be investor.

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