American Journal of Food Science and Technology, 2015, Vol. 3, No. 3, 74-81
Available online at http://pubs.sciepub.com/ajfst/3/3/4

DOI:10.12691/ajfst-3-3-4

Science & Education Publishing

Constraints and Compliances of Traceability in Low Grown Orthodox Black Tea Manufacturing Process

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Received June 05, 2015; Revised June 22, 2015; Accepted July 05, 2015

Abstract Traceability practices and their compliances in low grown orthodox black tea manufacturing process were examined, while proposing possible solutions for identified major drawbacks. The physical traceability in supply chain was considered one step forward and one step backward from the point of manufacturing, starting from auction/buyer back to supplier. Randomized stratified sampling was used. The traceability was evaluated using a checklist, end product sampling, open ended interviews, observations and internal document studies. The orthodox process was more complicated unlike other production processes due to the different separation techniques employed for grading and variety of grades produced because the sifting/grading was the key to number of different tea varieties. Major traceability issues were observed in leaf collection and grading operations due to complexity of separation through Myddleton, Chota, Michie and Winnower, which reduced the specific amounts produced, where bulking and blending process further extended complexity, while increasing the mixing of different made tea together with increased number of suppliers. Considering 1st, 2nd, 3rd dhool and big bulk with given separation techniques during grading; a single tea leaf could pass many paths before it end up in a specific product due to weight, size and shape of the leaf of a shoot based on the way it was rolled in orthodox rollers, where traceability up to tea bush, grading, blending and traceability of sample back to supplier was not fully complying. Nevertheless, supplier records, traceability after packing, traceability at dispatch and after dispatch were in full compliance, and other factors had varying degree of traceability compliances which make the compliances unachievable. Alternatively, if made tea is considered as bulk material, use of emerging technologies like Radio Frequency Identification (RFID) tags or/and DNA barcoding may be potential tools in rectifying such drawbacks and further research is needed to assess their efficacy in the field.

Keywords: *orthodox black tea, manufacturing, traceability, compliance, Myddleton shifter, supplier, grading, dhool*

Cite This Article: ChandanaVindika Kumara Lokunarangodage, Indira Wickramasinghe, and Kamburawala Kankanamge Don Somathilaka Ranaweera, "Constraints and Compliances of Traceability in Low Grown Orthodox Black Tea Manufacturing Process." *American Journal of Food Science and Technology*, vol. 3, no. 3 (2015): 74-81. doi: 10.12691/ajfst-3-3-4.

1. Introduction

Tea was known as a beverage at least for over 5000 years, it was initially considered as a medicine and later grew into a beverage which finally became the most popular beverage in the world or the second most important drink after water [1]. According to the Chinese legends, tea was first discovered in the time of Second Emperor and herbalist, Shennong in 2737 B.C.E, accidently when a dried tea leaf was fallen into the boiling water which was intended for quenching emperor's thirst; who drank boil water as a habit, while he was travelling to another region.

The commercial planting of tea in Sri Lanka was introduced by a Scotsman, James Taylor in 1867 [2]. Since then the Ceylon Tea has been the world's number one brand for over a century and the local tea industry has made a significant growth over the time while securing its position in the global market as a leading producer and exporter of high quality black tea. In terms of international trade, tea is one of the major export revenue earners for the country, where thousands of lives are depending on it directly or indirectly. In 2007, Sri Lanka was the fourth-largest tea-producing country according to global production statistics and the country has produced 318,470 tons of tea which contributed nearly 9.1% of the world's total tea production [3].

Nevertheless, country has dedicated over 221,000 hectares or approximately 4% of the total land area for tea cultivation [4]. Accordingly, Sri Lankan tea plantations can be categorized as large plantations as well as smallholdings and there are approximately 118,274 hectares of smallholdings with 397,223smalhodings [5] out of the total land cultivated; around 43% is managed by the corporate sector, with a production of about 35%, while the balance of 57% is in the smallholder sector, with a production of 65% of the total. The average productivity in the smallholder sector is substantially higher, at about 1,853 kg/ha compared to the corporate sector productivity of 1,459 kg/ha [6]. The production grows at an annual rate of around 10% [7] while current average production amounted around 328 million kilograms in 2012 with majority of black tea. The annual production contributed from 14 tea growing districts of the country with figures of low grown 62%, mid-grown 16% and high grown 22% respectively, while 99% of the produce was black tea out of which 92% of the produce were accounted as orthodox black tea and 7% was accounted as CTC (cut, tear and curl) [5].

Considering current trends in export market, tea is moving worldwide as a healthy beverage which has advantages of availability but disadvantage of complex supply chains. Today global food competition is more intense where stakeholders started to adapt their mind sets toward a more holistic approach on supply chain management while focusing on food safety and traceability in a farm-to-fork perspective [8] because food industry has drastically changed during recent decades [9]. Nevertheless, many governments are improving food safety measures to safeguard their citizens by increasing control at all stages of food production, processing and distribution with hazard analysis critical control point (HACCP) and traceability based food safety management systems (FSMS) such as ISO 22000: 2005. According to Food and Agriculture Organization of the United Nations, traceability requirements are gaining significance in the global tea economy, with the potential for significant impacts on the world's tea producers, which is expected that the demand for traceability will result in widespread industry restructuring, which will require institutional responses within each of the major tea-producing regions [10]. The traceability is used as a tool to track product movement through manufacturing and distribution chain up to end user and backward to raw material supplier. Today consumer safety is the firm concern, which is a matter of cooperation between all actors involved in food supply chain rather than a confrontation; with the sharing of information, use of common standards and languages to pinpoint the food safety issues [11].

Concern over food safety is becoming central to supply chain restructuring in tea. Due to the costs, sampling and methodological constraints associated with the monitoring of finished food products, there is a trend towards preventing contamination at source through monitoring of estate and factory processes. This is associated with traceability based food safety management systems such as Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), ISO 22000 and HACCP certification. The second driver of traceability is consumer demands for independent verification that teas have been produced in the absence of abusive labour practices, by respecting worker rights and providing a living wage to smallholders, and by not polluting the environment or threatening biodiversity [10].

According to the ISO 9001:2000 standard, traceability is defined as "The ability to trace the history, application or location of product or service that is under consideration"[12], which is a process that makes it possible to find the traces of the various steps (manufacturing steps, sources of its raw materials with relevant suppliers, controls and tests carried out) and locations (storage locations, equipments used to manufacture or handle it, direct customers and end users) a product has passed through from its creation through to its final disposal [11]. Traceability requirements in food supply chain due to consumer concerns were started to rise in the later part of nineteenth century with the discoveries of microbes as well as vitamins which were further increased due to the development of supply chains followed by the improved production methods [13]. The product traceability is the ability to follow the food movement through specified stages of production, processing and distribution in one step forward and backward at any given place of the food supply chain, while facilitating efficient product recall in the event of hazard left the production facility. As a result of global, integrated partner oriented approach throughout food supply chain, every operator must identify their product in a unique way while recording their destinations with the links between incoming and outgoing products as well as end users on databases [11].

Further, product traceability helps to determine the origin of a food safety problem and to comply with legal requirements while meeting consumers' expectations for the safety and quality of purchased products [14]. The aim of all these measures is to safeguard consumers from biological, chemical and physical hazards that may be present in food while implementing full traceability in food supply chains. According to the Kelepouris et al. [15], Morrison [16], Van Dorp [17] Viaene&Verbeke [18] full traceability or traceability throughout entire supply chain is essential for ensuring food safety and quality which was mainstream requirement to regain or maintain consumer confidence, where traceability cannot improve food safety or quality itself although it can provide necessary information and keep track of product movements [19].

Considering the complex nature of tea supply chain as well as the complex manufacturing operations involved in the tea industry, it is very difficult to identify the movement of a given supplier's raw material throughout the production process at a single glance. It was rarely discussed subject in many researches, where black tea's health benefits, chemical structures, disease prevention etc., has been extensively studied by many researchers. The existing manufacturing processes are also very old when compared to most of the modern food industries where traceability was not a major concern over a century. Hence the propose of this study was to find out the major drawbacks in the area of traceability by analyzing factors affecting the traceability process in orthodox black tea manufacturing and to find out possible solutions to the issues identified in the study.

2. Materials & Methods

The project designed to evaluate the problem areas of the tea manufacturing process related to the food safety applications and then to find out reliable solutions with minimizing or eliminating the existing complications through Pareto principle. The sampling plan was randomized stratified sampling, with the use of Factory Information.xls provided by the Sri Lanka Tea Board which was used to select tea factories based on the availability or non-availability of food safety or quality assurance certifications from the low grown orthodox black tea manufacturing industries. The most prominent area was the Southern province while Galle, Matara and Rathnapura districts were set as major target areas for the project execution due to the fact that most of the orthodox black tea factories were located in these areas and the easy access as well as shorter distances between factories, where concentration of factories were high. The project has two phases for execution and sample size for each phase was 30 factories where phase II was focused mostly on the factories which have ISO 22000/ISO 9001/HACCP systems or Good Manufacturing Practices with Japanese 5S implementations. However, there are number of tea factories which have abandoned the implemented food safety management systems due to various reasons, where additional priority was given to understand the problems they faced, that led to abandoning as well as to find out the remaining practices and their efficacy.

The first stage was completed with gap analysis to evaluate the basic major issues which has more impact on food safety and the product quality with the evaluation of 25 tea factories that have not implemented ISO 22000/HACCP food safety management system (FSMS). The second stage was designed based on the output of the first stage audits, where another set of 20 factories were analyzed and which have ISO 22000 FSMS/HACCP or previously implemented but currently abandoned. The audits had two dimensions where first major audit was targeted to identify the issues prevailing in the food safety management systems and their supporting documents while second objective was to find out traceability of the manufacturing process as a part of generic model development. The internal audits were designed based on ISO 22000 food safety management system requirements and root cause analysis carried out at the gap analysis stage which pointed out the issues in industry as well as strategic approaches to the problems identified while traceability was a major concern from the gap analysis.

In addition to the gap analysis and internal audits conducted in stage I and stage II, separate traceability study was carried out in parallel to the stage I and II to understand the traceability applications and practices in tea industry using over 40 tea factories with or without ISO 22000 or HACCP FSMS or ISO 9001 QMS. The selected factories were evaluated based on the visits made in parallel to gap analysis carried out at phase I and internal audits conducted in phase II. Required data was collected through standard check list followed by open ended discussions. A traceability exercise was conducted for a selected made tea sample, practically trying to trace back green leaf supplier for selected sample with the help of available documents/records and employees working on relevant processing areas.

The two testing criteria were common for all the factories evaluated and special attention was given to the factories which were currently practicing ISO 22000/ISO 9001/HACCP systems or previously followed even though the certifications were expired. The check list was prepared considering the various standard requirements of traceability.

The results of the study were analyzed using MINITAB 17 Version and 1-Propotion test was applied for the results at 0.05 significant levels. Hypotheses were built based on the proportion of factories which were complied with traceability factors and results were separately analyzed for every factor.

3. Results and Discussion

According to the evaluations carried out, over 45 factories were observed and complete data was observed on 40 factories with or without ISO 22000, HACCP or ISO 9001 certifications. The traceability was evaluated using a check list, end product sampling, open ended interviews, observations, and internal document studies in all the tea factories. As to the results, traceability was found in place up to a certain extent in all the tea manufacturing processes from one step forward. It was mostly limited to the made tea up to auctioneer or the wholesale buyer after completion of the manufacturing process, where made tea could be traced from manufacturer through product coding, manufacturing date, brand, and name of the manufacturer up to auction and through auction records purchaser can be located.

According to the CBI, the consumer markets were dominated by the popular blended brands which can contain up to 36 different types of tea varieties that were blended in the consuming country to ensure the unique taste of their brand at a competitive price where tea buyers source different teas from around the world mainly China, India, Kenya and Sri Lanka [1]. Accordingly, buyers blend tea after purchasing according to their brand's requirements depending on the market and cost. Therefore, the process was complex and the traceability will lead to a bunch of manufacturers rather than a single manufacturer.

Thus rest of the traceability was not studied because most of the purchases were export oriented and it was beyond the research objectives. However, that can be traced up to the consumer since no processing was involved other than blending, repacking or value addition according to the consumer preferences. Thus traceability of a product complains can be elaborate as consumer claim to retailer, who claim to wholesaler and who will then inform the buyer through auctioneer and the manufacturer. If there is a product recall, the same channel can be used vice versa.

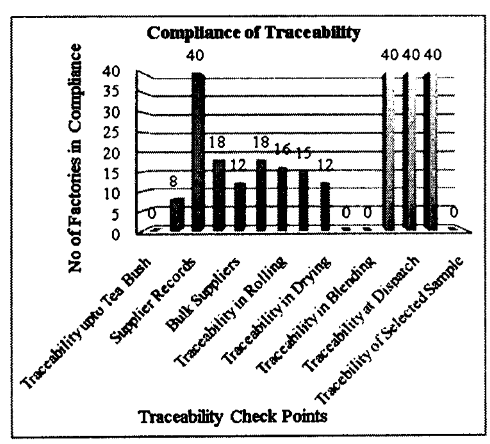

Figure 1. Constraints and Compliances of Traceability in Low Grown Orthodox Black Tea Supply Chain

The results of the study was given in the bar chart above (Figure 1), which illustrate the traceability practices as well as the achievements in the factory flow level. Further to the results obtained traceability up to tea bush, traceability in grading, traceability in blending and traceability of sample back to the supplier wasn't fully complying according the study sample ($p < 0.05$). On the other hand, supplier records, traceability after packing, traceability at dispatch and traceability after dispatch was fully traceable or all the tea factories were in compliance with these four factors ($p = 1$) . As a rule of thumb, other factors had varying degree of traceability compliances, which indicated that those areas were more or less neglected but it was not impossible. The Figure 2 below shows the probability of implementation and it further prove that what were already implemented and what was not achieved due to explained reasons or neglected according to the representative sample.

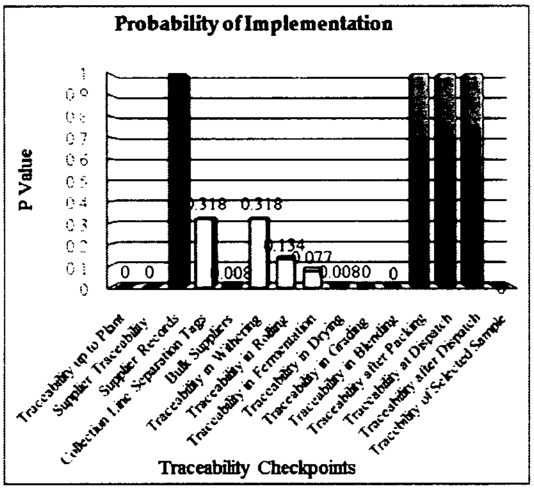

Figure 2. Implementation Probability of Traceability in Low Grown Orthodox Black Tea Supply Chain

When considering traceability in one step backward, none of the brought leaf based tea factories were able to exactly locate the farmer or the field where green leaves were harvested. Large estates were able to locate the field of the harvesting carried out, but they also unable to locate the records of exact tea bush or the labourer who harvested a given green leaves which mostly process in their own production facility. On the other hand, smallholder suppliers were more critical because their leaves were mixed each other while collecting and transport, where traceability was only possible up to a bunch of suppliers.

Bearing in mind the traceability up to tea bush which was the primary objective, a quantity of 4.50 – 4.65 kg of green leaves were required to manufacture 1kg on made tea (final product) [20]. 1kg of green leaves were to be harvested from 20 - 30 tea bushes with average yield where it is extremely difficult or almost impossible to practically locate the exact tea bush in the case of a product complain or hazard occurrence. The most possible paper based system could reach the leaf collectors or bunch of suppliers approximately, but it was impossible to locate the exact supplier or tea bush who contributes to the issue. Thus one-step backward traceability in orthodox black tea manufacturing was rarely achieved due to following reasons in smallholder suppliers. Most of the suppliers were smallholders who had less than one hectare of lands, which produce less than a single roll charge in a one supply of green leaves. It was usually varying around 3 – 15 suppliers at a time. Tea cultivation requires a relatively small investment, and the risk of complete crop failure is low. Problematic issues for smallholders producing bulk tea products include low farm gate prices, poor extension services and limited marketing channels [1]. As a result, their tea leaves were mostly collected through leaf collectors. According to keleporis et al, successful implementation of supply chain traceability calls for co-operation among all the stakeholders of the supply chain [15]. According to the interviews conducted, leaf collectors were not educated enough by manufacturers to keep traceability records. On the other hand, cost of additional labour and transport was high, where leaf collectors were operating at little margins. Nevertheless, leaf collectors as well as factory employees also believe that tea leaves are a uniform and homogenous raw material; origin in similar fields which cannot be distinguished each other very easily. Thus it was very difficult to motivate them to practice traceability in supply chain, where extreme competition for leaves in the market has the bargaining power for them to change the manufacturer at any time without notice.

After withering during release to the rolling process, small quantities were bulked or large quantities segregate to make a single batch of size about 250kg depending on the dryer capacity, which was call the charge, [21] and this activity increased the mixing of direct smallholder suppliers as well as leaf collectors. According to the study sample (as shown in the Figure 1 – traceability compliance), 18 factories maintain collector bulks with identification tags ($p > 0.05$), thus the leaf could be traced with time records backward to leaf collectors as well as bunch of smallholder suppliers at a given date but it was impossible to trace up to the exact supplier or the tea bush. The same leaves could be traced forward through rolling, fermentation, drying up to fiber removal, easily with time records when the production was arranged in such a way.

Typically, orthodox black tea manufacturing process was much more complicated unlike other production processes (e.g. CTC) due to the different separation techniques employed as well as the number of different varieties produced. Hence, most critical part of the tea traceability systems was to trace the product within the manufacturing process. The sifting/grading was the key to number of different tea varieties and ungraded dry tea leaves initially pass through Myddleton after fiber removal. According to Samaraweera, the Myddleton bubble tray stalk extractor has an oscillation motion of 200 to 220 oscillations per minute of two aluminum bubble trays with perforations where bubbles impart a string action at the bottom of the layer which makes long particles such as fibers or stalk to float. It helps small and round particles to settle at the bottom of the layer while top particles to fall through perforations. To achieve this action, it must be feed with a continuous thick layer without exposing the bubbles, which will sort the stalky long leaf portion by passing through a tray that is used to separate long leaf particles and stalks at the beginning of the sorting process [21].

Thereafter, Chota and Michie shifters were used to separate uniform sizes and then to different varieties. Michie oscillatory shifters were equipped with one or two trays stacked one on top the other with a slight slopes towards forward direction that gives oscillatory motion on the vertical plane which help particles to jump forward at 250 to 260 oscillations per minute. Michichi shifter was used to separate long and wiry particles which were basically used to produce long leaf and wiry grades [21]. After separations, semi graded tea was then passed through a winnower to separate according to the weight. The winnower is used to separate light tea particles such as flakes, fibers, tea fluff and extraneous matters such as sand or dirt [21].

However, this process was very complicated and very difficult to understand easily for an average person. Considering 1st dhool, 2nd& 3rd dhool as well as the big bulk, given generic process flowcharts (Figure 3, Figure 4 and Figure 5 below) were drawn where it was obvious that single tea leaf could pass many paths before it end up in a specific product due to the weight, size and the shape of the leaf of a shoot based on the way it was rolled in the orthodox rollers.

On the other hand, consider the same leaf if it broken to small sizes and large sizes they normally end up in two different grades. The same shoot's tender leaves will mostly end up in first grades while matured low weight leaves will mostly end up in second grades based on the weights. Considering the complexities involved, the Figure 3, Figure 4, and Figure 5 shows the number of different grades produced in a given dhool. It was almost 32 for a first dhool (Figure 3) considering the generic processes without 2nd or 3rd grade products where their sizes were different from one another as well as different parts of the tea shoot.

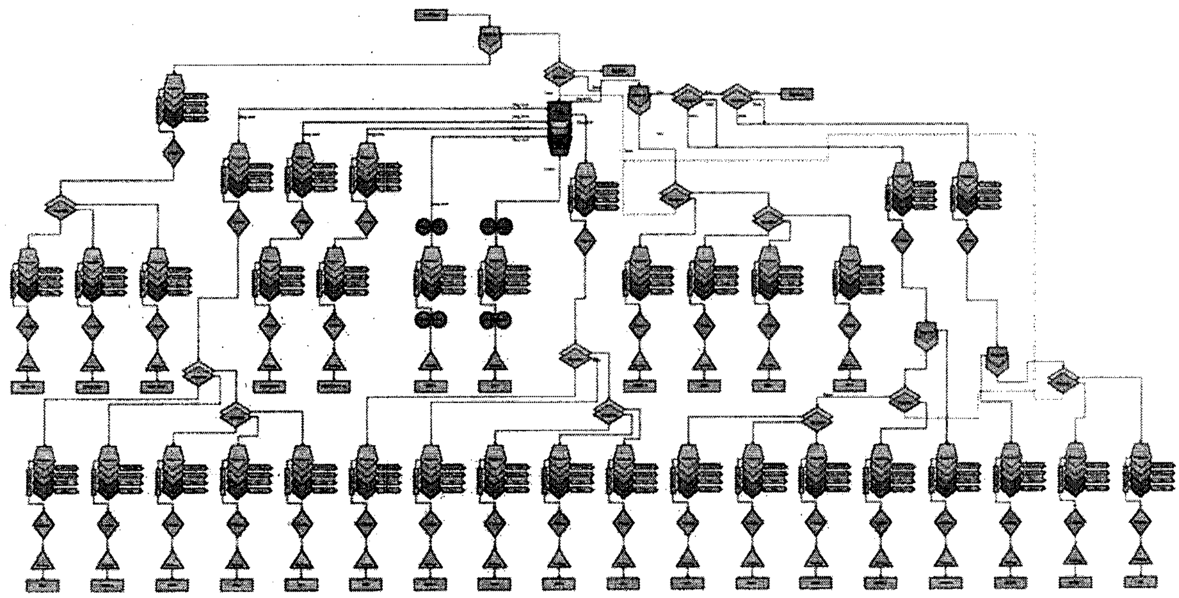

Figure 3. Graphical representation ofgeneric process flow chart for the 1stDhoolsifting program of orthodox black tea

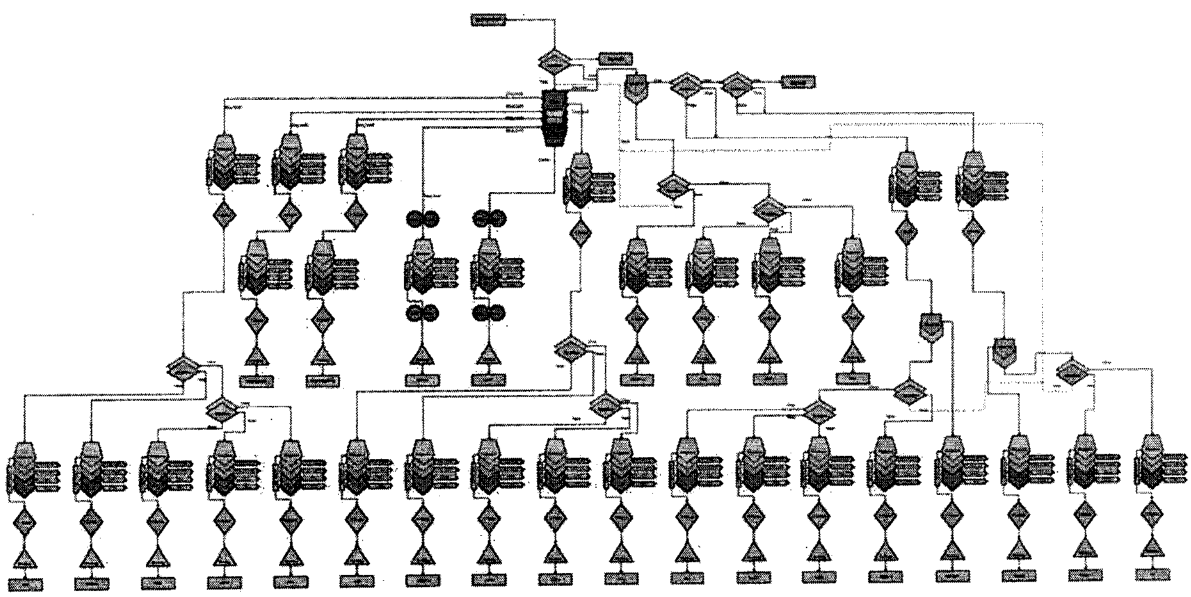

Figure 4. Graphical representation ofgeneric process flow chart for the 2nd& 3rdDhool sifting program of orthodox black tea

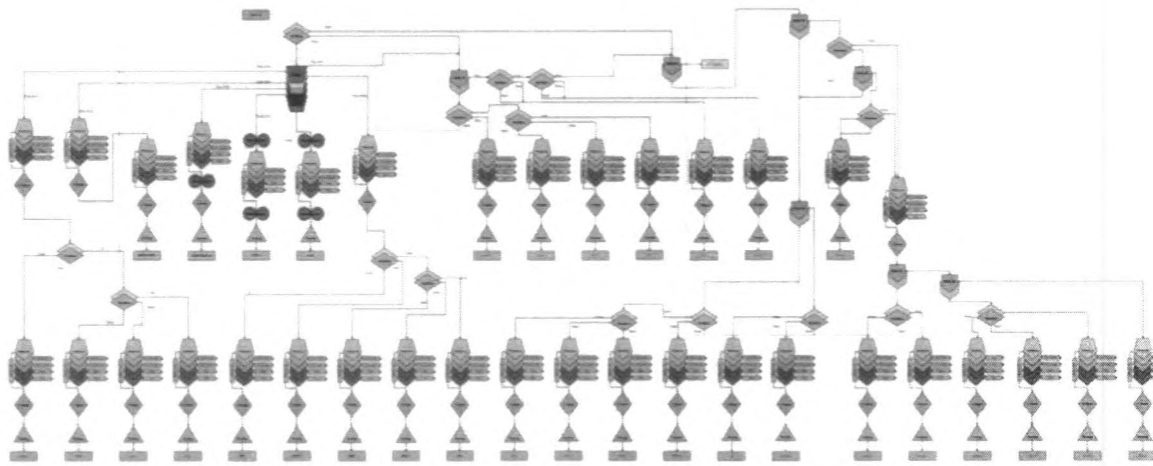

Figure 5. Graphical representation of generic process flow chart for the Big Bulk sifting program of orthodox black tea

This phenomenon was almost same for all the dhools where it wasn't a very easy process to keep records of the product movement. Nevertheless, the second grades were much less discussed in the orthodox black tea manufacturing process but those amounts were also massive and their movements were never recorded in the industry on accurate manner, where the existing traceability practices were not complete. The existing systems had introduced various documents to keep traceability tracks on the product movements, but none of them were able to comply with the theoretical traceability requirements according to the definition of traceability[12].

According to the given process flow diagrams below, one tea leaf might pass many times through Myddleton, Michie and Winnower as well as the Colour Sorter before it reached the final grade. Some leaves may recycle the same path again and again with mixing new coming ungraded teas such as throughput of 5mm Myddlton which go back again to Chota (red line – Figure 3, Figure 4 and Figure 5) and passing through same sieves before end up in a final grade. On the other hand, each time the product went through winnower, based on the weight; it separates the product in to 1st grade, 2nd grade, 3rd grade and fiber while removing stones and other extraneous particles and reducing the bulk into small quantities. 1st grade was proceed with next steps of manufacturing process, while 2nd and 3rd grades were followed separate pathways which generates second quality tea products which were usually called second selling mark products. Considering 1st dhool, 2nd dhool, 3rd dhool and big bulk, when each of these process flowcharts were equally complicated and largely distributed, it was very difficult to follow a paper based or even a digital method to track down the traceability of a specific tea leaf.

Due to the continuous feeding and requirement of uniform thickness in Middleton shifter; batches couldn't be separated accurately rather than guessing. Thus there must be number of documents and complex storing systems to identify different batches as well as batch wise separation techniques which will add more cost to the production. While dried tea was passing through shifters within grading room operations, the same bulk was separated into small different grades based on leaf size, type, dhool, weight and buyer requirements where orthodox black tea has around 30 different grades basically which further creates issues in reaching the initial leaf supplier.

There are various other processes involved, but these processes were the major critical points for the traceability issues in orthodox black tea manufacturing unlike the cut, tear and curl (CTC) process where it is easily traceable due to non-complex process which give less varieties as well as large quantities. In orthodox process, the output of a single grade was small where several batches were required to prepare a standard quantity for packing or as to buyer requirements, thus bulking is needed.

Figure 6. A Typical Blending Operation

The blending (Figure 6) was carried out to give specific product characteristics to a given tea product where different grades are mixed together. Hence this process further increase the traceability issues while increasing the number of raw material suppliers as well as individual tea plants contributing to a given tea product. Nevertheless, these areas still can be traceable with a proper organization of production flow and better recording systems which was not available in any of the systems evaluated. The cost is one of the major factors which decide the implementation of such measures, because even though the factories are fully dedicated and implemented such systems, the buyers do not pay attention to such efforts while they were involved in purchasing. Thus it is inappropriate to request complete treatability from manufacturers without providing solutions to the areas mentioned in the study.

On the other hand, if orthodox black tea manufacturing was considered as a bulk material, the traceability can be achieved with less hazardous work load where bunch of suppliers or fields were the primary objective. Then paper based traceability systems can be developed to trace single day's production which can be more easily segregated while storing and recording where it can be traced through grading and blending up to packing. Nevertheless, it can be trace one step backward practically up to bunch of suppliers through existing records while adding few new records within grading operation from drier out to finished product packing. Rest of the areas of manufacturing namely receiving, withering, rolling, fermenting and drying can be managed through addition of time records or codes to the existing food safety management systems.

Finally, if the cost is bearable to the consumer, DNA barcoding is a widely used molecular-based system, which can identify biological specimens, and is used for the identification of both raw materials and processed food, which can be possible to employ to identify exact issue concerning samples [22]. On the other hand, Radio Frequency Identification (RFID) tags also can be integrated to track down the raw material movements as well as finish product by using the passive RFID tags with the bulk storing bins from field to the factory and then after drier moth to the packing since raw material and finish product both moved within plastic crate which can be continually used with a reader. The passive RFID tags are designed to depend on the tag reader as its power source where reader unit can communicate with the tag within 6 meters which are low in product cost and it is manufactured for disposal with disposable consumer products [23]. Considering current developments in RIFD tags technology, it possibly can be used in the complicated operations in orthodox back tea manufacturing process to track down intermediate product movement within the factory environment where the production should plan according to the requirements while synergizing with existing paper based systems to make it workable. However given model will be able to identify the traceability on the bulk movement where individual supplier and the end user can be located. But these technologies are not currently applied in tea trade where it will not guarantee the accurate identification of exact tea bush in an event of hazard occurrence which needs further research to explore the possibilities of exact application of the given technologies.

Accordingly, the research recommends considering tea as a bulk material like edible oils in the event of processing where it is really practical to consider traceability after made tea left the factory and if there is any food safety issue manufacturer has to address all the suppliers in the supply chain and check their plantations for identification of abnormalities, if necessary. If the made tea is considered as a bulk material, it will be helpful to develop user friendly, realistic and practical paper based traceability models which will not increase the product cost or unnecessary documentation works for the quality assurance system operators.

4. Conclusion

As to the results, traceability was found in place up to a certain extent in all the tea manufacturing processes from one step forward. The research was limited to the made tea up to auctioneer or the wholesale buyer after completion of the manufacturing process, where made tea can be traced from manufacturer through product coding, manufacturing date, brand, and name of the manufacturer up to auction and through auction records, purchaser can be located.

When considering traceability in one step backward, none of the brought leaf tea factories were able to exactly locate the farmer or the field where green leaves were harvested. Large estates were able to locate the field of the harvesting carried out, but they also unable to locate the records of exact plant or the labourer harvested a given green leaves which mostly process in their own production facility. On the other hand, smallholder suppliers were more critical because their leaves are mix each other while collecting and transport where only possible up to a bunch of suppliers. Bearing in mind the traceability up to tea bush which was the primary objective, a quantity of 4.50 – 4.65kg of tea leaves were required to manufacture 1kg on made tea. 1kg of green leaves were to be harvested from 20 - 30 tea bushes with average yield where it was extremely difficult or almost impossible to locate the exact tea bush in the case of a product complain or hazard occurrence. The most possible paper based system could reach the leaf collectors or bunch of suppliers approximately, but it was impossible to locate the exact supplier who contributes to the issue or tea bush.

Typically, orthodox black tea manufacturing process was much more complicated unlike other production processes due to the different separation techniques employed as well as the number of different grades produced. Thus most critical part of the tea traceability systems was to trace the product within the manufacturing process. The sifting/grading was the key to number of different tea varieties. Considering 1st dhool, 2nd dhool, 3rd dhool and big bulk, when each of these process flowcharts are equally complex and largely distributed, it is very difficult to follow a paper based or even a digital method to track down the traceability of a specific tea leaf. According to the given results and the observations it was obvious that orthodox black tea production process was very complicated, where it was suitable to consider as a bulk material in the event of traceability which help to develop user friendly traceability systems in orthodox black tea manufacturing process. On the other hand, use of emerging technologies like Radio Frequency Identification (RFID) tags or/and DNA barcoding may be potential tools in rectifying such drawbacks and further research is needed to assess their efficacy in the field.

Considering all these factors, it was obvious that tea traceability practices were very complicated to the manufacturer and product was not priced considering these critical factors. Thus requesting traceability from the consumer's tea cup back to the tea bush that supplied green leaves to produce the given made tea sample was not justifiable as well as very difficult in the manufacturing process. However, educating all the stake holders may help to improve the traceability practices up to certain extent, but if the manufacturer can increase the hygienic practices to improve the food safety of the product, while educating all the stakeholders in supply chain that will be more meaningful than considering the traceability as a critical buying factor due to the complex processing nature of the product.

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