Recipes for success – innovating the pepper oleoresin production at Synthite

Summary

This case examines the operations at Synthite oleoresin plant in Kerala, India. It discusses the problems that company faced in production of pepper oleoresin, one of its flagship products. The case traces the problems to the Make-to-stock production strategy and to several material flow practices at the plant.

The case provides quantitative data to analyze Synthite's inventory management, material flow and order lead times. The case outlines in brief the company approach to addressing the problems it faced and encourages student to think critically about issues and other solutions.

Students are encouraged to use the accompanying Excel data sheets to calculate and analyze different production parameters.

Recipes for success – innovating the pepper oleoresin production at Synthite

On a hot summer day, Aju Jacob wondered how best to deal with the high levels of inventory and the constant need to expedite orders at Synthite, a medium size spice business that his family founded. He was attending the executive MBA program at the Indian School of Business and wanted to bring in new ideas into his operation.

The large variety of products and unpredictable demand made it very difficult for the spice plant to fulfill customer orders on time despite carrying high levels of inventory. Often they could not fill a 100-kilo order on time despite having 40-50 tons of stock because the precise product requested was not available. Almost daily, they had to open up packaged finished product from stock, re-blend it to specs of an incoming customer order before shipping. The result was a lot of wasted effort and frustration for the workers.

In a discussion with Minu Thomas, Synthite's head of planning, Aju wondered whether the paint industry's practice of mixing colors on demand could be implemented at his company. Any changes implemented had to ensure that the company could meet the short lead times (often of the order of one week) required by customers, especially those from overseas.

The Pepper Family

Buying and consuming spices is so common today that it is hard to believe that they were valued as high as gold and silver many years ago. Men and governments were willing to go to the ends of the world to source spices and fight wars to control the spice routes across the globe. India has occupied a very important place in the spice trade; specially pepper. Historically, black pepper has remained one of the most widely used and most important spices, often referred to as "black gold." Trade in black pepper from India goes at least as far back as the Roman Empire. Edward Gibbon has written in *The History of the Decline and Fall of the Roman Empire* that pepper was "a favorite ingredient of the most expensive Roman cookery."

Today, pepper is consumed in different forms – whole, powder, and derivatives such as oil, oleoresin, isolates and nutraceuticals[1]. Light pepper berry is the starting point of all these pepper forms. It has three major components– oil, piperine and oleoresin. Oleoresin is the solvent extractable portion that contains small amounts of both piperine and essential oil. On average, one metric ton (MT) of light berry yields about 35 kilo (3.5%) of pepper oil and 105 kilo (10.5%) of oleoresin.

Oleoresins "provide flavor profiles characteristic of the ground spice or herb with a more rapid flavor release in a concentrated, oil-soluble, liquid form."[2] This makes it highly suitable for industrial applications in food processing, beverages, pharmaceuticals, and chemicals.

[1] A nutraceutical, also known as a phytochemical, is a natural, bioactive chemical compound thought to promote health, prevent disease, or act as a medicine. Foods containing nutraceuticals are often referred to as "functional foods."
[2] See www.mccormickflavor.com/subcategory.cfm?subcategory=25.

Synthite Industries Limited

Synthite Industries Limited, established in 1972, was a family owned conglomerate based in Kerala, India. It processed and supplied a wide range of spices in diverse forms like whole, powder, oil and oleoresin. Its product range included pepper, red chili, nutmeg and ginger. Synthite pioneered the Spice Oleoresin trade in India and was the largest exporter of Spice Oleoresins and essential oils in 2011. In fiscal 2011, it exported about 450 MT of pepper oleoresin that formed 20% of their revenue that year.

Synthite produced four broad categories of oleoresin – black pepper, white pepper, decolorized and non-additive. The black pepper category represented bulk of demand (over 90%). Among these categories, they produced over a hundred variants that represented customer needs for varying oil and piperine content. Exhibit 1 provides monthly sales of these variants at Synthite for the year 2011-12.

In addition to oleoresin, Synthite also produced high value pepper oil that sold at about Rs.10, 000 a kilo as compared to oleoresin sale price of Rs. 1000 a kilo.

It had manufacturing facilities in six locations in India and one in China that it opened in 2012. Synthite sold its products in over 100 countries and had offices in U.S., China and Sri Lanka and warehouses in Rotterdam and Buffalo, U.S.

The company also had interests in diverse fields including bio ingredients, hospitality, spices, farm technology, real estate, and wind energy. It planned to achieve a turnover of US$ 500 Million by 2020.

The Oleoresin market

According to George Paul, CEO Synthite, global oleoresin production (including all kinds of spices) in 2010-11 was about 9000 MT[3] with Synthite's share at 35%. Spices Board of India estimated Indian exports of oils and oleoresins at 7,600 MT in 2010-11[4] with a compounded annual growth rate of 4.8% over the previous five years. Prashant, cost accountant at Synthite, in an interview estimated the pepper oleoresin market at 2000 MT with an annual growth rate of 3% - 4%. India had a virtual monopoly on the pepper oleoresin market, with Synthite supplying about 25% of the global demand.

Its customers included FMCG food manufacturers and flavor and color houses. The latter were boutiques that created unique flavors and fragrances from basic product.

Drivers of competitive advantage

Oleoresin had become a commodity product with thin margins. Reducing cost and moving up the value chain were the only ways to survive and grow. Synthite had achieved cost efficiencies through a smart global raw material sourcing strategy (discussed under raw material sourcing) and maximising plant utilisation by adding a diversified set of spice products – ginger, nutmeg and chilli to name a few. The diversification also addressed growing customer trend of shopping for all their spices in one place. Being a one-stop shop was important for Synthite's success.

[3] George Paul in Synthesis (in-house magazine at Synthite), July-September 2011
[4] http://www.indianspices.com/html/s0420sts.htm

To meet the Chinese cost challenge, they had started China operations in 2011, for sourcing and production. They had also moved into high value flavorings with a joint venture in Austria.

According to Nitu Jacob, Marketing Manager Key Accounts, short delivery times were a critical success factor in the food business. George Kurien, marketing manager, Europe, added, "the moment we quote 2 to 3 weeks delivery, the customer starts looking at other sources; quoting anything more than one week just shoos the customer away."

Ability to execute orders of any quantity was also a key to success in the oleoresin market. Evidently, Synthite accepted orders in all sizes – from ½-kilo right up to thousands of kilo (Exhibit 2 – a sample order book for November 2011). Synthite's big customers signed annual price and volume contracts and requested delivery of small quantities several time in the year.

Synthite Oleoresin Operation

Raw material sourcing

Light black pepper berry (known as light berry) was the key raw material for oleoresin production. To get the best prices, Synthite sourced off-grade[5] berries that met the needs of oleoresin production. Global sourcing from Sri Lanka, Indonesia, Vietnam, and Madagascar (with different harvesting periods) helped Synthite spread procurement over 8 months in a calendar year. Synthite also sourced small amounts of white pepper berries that were used for a few specific customer orders.

Average berry stock during 2010 and part of 2011 was over 900 MT, roughly equal to three months production (Exhibit 3 & 4). This occupied most of the 12,000 sq. ft. warehouse.

Besides the cost of warehousing, holding inventory was expensive because the economic value of the berries literally evaporated. According to Mr. Paily, one of the oldest employees, now part of the planning department, "0.2% of the essential oil evaporated during storage causing a loss of about Rs. 19 million every quarter at a conservative price of Rs.10, 000 per kilo of oil."

Synthite oleoresin production

Oleoresin manufacturing at Synthite was a four-stage process (Exhibit 5) – distillation, extraction, homogenization and blending. First, the company distilled pepper oil from the berries. Second, they extracted crude oleoresin from the de-oiled remains from distillation. Third, they homogenized crude oleoresin to obtain clear, uniform density, free flowing oleoresin (also known as semi-finished good or SFG). Finally, they blended the SFG with required quantities of oil and other additives to produce finished goods (FG) as per customer specifications.

Distillation

Synthite used steam distillation to separate the volatile pepper oil that was subsequently condensed and filtered to get the saleable product. The other output of the process was de-oiled cake that was rich in oleoresin.

[5] Off-grade berries are those that have dropped off the plant or those plucked a month before reaching their prime. Such berries are cheaper than ripe berries that are harvested when ready.

Synthite had three steam distillation columns with capacities of 2 MT each. These operated 24 x 7 in twelve-hour cycles. Each cycle processed 6 MT of berry and yielded about 210 kilo (3.5% by weight) of pepper oil and remaining de-oiled cake. The columns were manually loaded and unloaded. The de-oiled cake was transported to the continuous extraction plant (CEP) on forklift in 850-kilo barrels. The company had signed up a few external distillation vendors as a fallback mechanism if its units failed.

Continuous Extraction

De-oiled cake mixed with additional berries (to get a 75:25 mixture) formed input to the CEP. The CEP processed de-oiled cake at about 500 kilo per hour to yield about 1260 kilo (10.5% by weight) crude oleoresin every 24 hours (known as a crude batch). The company also had extraction plants for other spices that they could use for pepper oleoresin if required.

The crude batch, at this stage was a hot (90° C) dark green semi-solid with uneven density and very high viscosity. It needed to be made uniform and free flow for further processing.

Homogenization

Homogenization plant converted crude batch into a semi-finished good (SFG) batch. The process involved ten hours of stirring and cooling (to 25° C – 30° C) in a charging kettle (2 MT capacity) followed by a sand mill operation. The charging kettle required cleaning after every seven crude batches. This operation took eight hours. The sand mill was a cylinder containing ceramic balls, rotating at high speed. The balls disintegrated the large fluid particles in crude batch to create a lower viscosity, uniform density fluid. The sand mill processed a crude batch in about seven hours (200-250 kilos per hour). The output of sand mill was known as the semi-finished good or SFG batch.

A seven (7) MT tank collected the SFG batches. The tank took five SFG batches to fill. The SFG was continuously stirred in the tank and when the tank was full, the SFG was stirred for another four hours. The full tank was emptied for the next set of SFG batches. There were three ways they did this – transfer SFG to mixing kettles to blend any open customer orders, blend some high volume variants for stock (make to stock or MTS) or transfer SFG into barrels for external storage.

Every new SFG batch was tested together with any previous material in the tank for oil and piperine content (standard tests – see Exhibit 6). As a result, five standard tests were required for a full tank. The test data was used to calculate additives required while blending FG to a customer specification.

Blending

SFG was blended with additives and pepper oil to bring it to customer specs. The shipped product variants normally contained 15% – 20% oil and 35% - 55% piperine. The company had three mixing kettles (capacities 1.7MT, 2MT and 3MT) for this purpose. The pumps loaded SFG in these kettles and unloaded FG into barrels. The blending time varied with the quantity blended. Mixing kettles had constraint of 250 kilo on minimum they could blend. orders of 1 kilo or less were samples ordered by the customers. These were either produced in the laboratory or drawn from other FG lots.They repeated the standard tests on all FG batches. In addition, some FG batches (20%) also underwent extended tests (exhibit 6) as specified by the customers. Most of these tests took several days and were costly (exhibit 7). This meant the kettle was blocked for several days, as the FG could be unloaded only after test result proved positive.

Exhibits 8-10 illustrate the blending capacity calculation for FG blending under the two test conditions.

Strategic and Operational challenges

The company had come a long way since it started operations in 1983. It now produced an increasing variety of products (about 100) with varying logistical demands (e.g. short due dates, specific features, different packing) for different market segments. The growing complexity, however, made forecasting and inventory management a challenge. According to Aju Jacob, the company could not make reliable sales forecasts owing to the significant fluctuation of demand (Exhibit 1).

The company had great difficulty meeting customer demand for a one-week lead-time. Production lead times were high, ranging from two to four weeks for some products (Exhibit 11).

To supply customer orders quickly, the company stocked some of the high volume products as FG. For the year 2010 and part of 2011, the average monthly FG stock was about 34 MT (Exhibits 3 and 4). Despite having many days of FG inventory (Exhibit 12), the company rarely seemed to have the right product in stock at the right time. Even when the ordered product was in stock, often it either required new packaging or had to be reblended because the product had undergone sedimentation and hardening due to the long time in stock. For blending the product had to be manually transferred and reprocessed in a mixing kettle to bring it into a shippable state.

SFG inventory was also high at Synthite. For the year 2010 and first three months of 2011, the average monthly SFG stock was about 11 MT (Exhibits 3 & 4). This inventory was stored in barrels.

The manual material transfers were frequent at Synthite – loading SFG from barrel into mixing kettle, reloading FG into mixing kettle for reprocessing and daily transfer of de-oiled cake from distillation to extraction plant. These material transfers were an operational nightmare that resulted in loss of material and capacity and extra costs of re-processing and retesting.

Another bottleneck was the changeovers. The entire production line required cleaning when changing over from black pepper oleoresin to manufacture of variants like non-additive, decolorized and white pepper oleoresin. This meant the line was down for some time and incurred extra cost (Exhibit 13). In the years FY10 and FY11, the variants formed 12% of the number of orders and 3% by product volume.

In one instance a changeover had triggered a heated debate among the planning, production and senior management on the execution of a new customer order (see box).

… A customer urgently needed eight (8) MT of an oleoresin variant. We had 60 MT of stock but none matching the customer specs. So, some of the finished goods needed to be recycled. Production quoted 3 weeks. This should normally take less than a week.

The reason: this involved laborious and time-consuming operations like emptying the line of previous batch of decolorized pepper, cleaning and setting it up for black pepper, transferring back very viscous and hardened FG from barrels to mixing kettle and finally the blending.

Just the thought of such possibility raises mental blocks among workers. It is so wasteful and meaningless.

At the same time, it left management exasperated. It was ironical that company had 60 MT of finished goods but nothing shippable in quick time.

Workers did it in this instance but it left management thinking about what they could change to make operations smooth and efficient.

- Minu Thomas
Head of Planning

In the end, such incidents left everybody frustrated – the sales team for their inability to commit to short lead times and the production team for having to do avoidable work that disrupted smooth production, and the planning team for not having any flexibility to respond to unanticipated orders. Customers were also hurt because they seldom got their material in time.

The Choice Ahead

Aju and his management team were looking for solutions that would help them profitably meet customer orders on time. They hoped that any improvement in on time delivery would also help them reach their growth target of 40 percent for the coming year. A key idea promoted by Aju was that of a mother batch. The mother batch concept was inspired by the paint industry where semi-finished goods were stored and mixed to order once customer orders arrived. Similarly, Synthite hoped to store SFG rather than finished goods. If this SFG was mixed to order, Synthite could better ensure that production matched with demand. Implementing the mother batch concept would require additional investment in equipment (see costs in Exhibit 14). The hope was that it would significantly reduce lead times and inventory.

Exhibit 1 - Monthly Demand for Oleoresin in 2011 (April 2011 – March 2012)

Product	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Product Totals (Kilo)
SKU 06	6500	501	16733	5260	12688	7100	5568	7950	12880	11978	17400	10225	114782
SKU 04	5232	2018	17491	7633	7435	5365	4529	13096	5836	3397	7945	7830	87808
SKU 56		5663			1398			15221				2180	24461
SKU 44		500			3990	5130		4370	8170			2170	24330
SKU 09	1910	2730	1790	1510	1325	1960	2500	642	1920	1150	400	1750	19587
SKU 01	1670	478	955	2237	1440	3513	735	1845	729	1665	737	1550	17552
SKU 11				3560					5000	1		840	9401
SKU 15			1883	100	358	3806	254	930	255	223		765	8574
SKU 39		1998			1998			2000		1008		690	7694
SKU 46			3000		2000		2000					685	7685
SKU 08	2000				2000	2000						590	6590
SKU 26			6000									590	6590
SKU 33	2000		1200	1000		1600	0					570	6370
Rest 41 SKUs	5586	3427	2967	6802	4313	7465	4271	6101	3551	7526	1347	5235	58590
Monthly Totals (Kilo)	24897	17315	52019	28102	38945	37940	19857	52155	38340	26947	27829	35670	400015

Exhibit 2 - Company Order book for November 2011

Sale Order Date	SKU	Qty	Sale Order Date	SKU	Qty	Sale Order Date	SKU	Qty
01-Nov	SKU 6	3900	13-Nov	SKU 6	300	21-Nov	SKU 9	1
02-Nov	SKU 1	1	14-Nov	SKU 1	1	22-Nov	SKU 1	0.03
02-Nov	SKU 17	1	14-Nov	SKU 6	500	22-Nov	SKU 1	5*
02-Nov	SKU 4	1	14-Nov	SKU 9	40	22-Nov	SKU 1	1260*
02-Nov	SKU 4	5	15-Nov	SKU 44	4370	22-Nov	SKU 19	700
11-Nov	SKU 9	50	15-Nov	SKU 6	3000	22-Nov	SKU 4	20
07-Nov	SKU 1	100	16-Nov	SKU 4	100	22-Nov	SKU 56	4525*
07-Nov	SKU 4	630	16-Nov	SKU 6	100	22-Nov	SKU 56	6171*
07-Nov	SKU 7	900*	17-Nov	SKU 15	150	24-Nov	SKU 58	2000*
07-Nov	SKU 9	100	17-Nov	SKU 4	500	27-Nov	SKU 1	1
08-Nov	SKU 1	25	17-Nov	SKU 4	510	27-Nov	SKU 1	250
08-Nov	SKU 1	200	17-Nov	SKU 9	200	28-Nov	SKU 39	2000*
08-Nov	SKU 4	50	20-Nov	SKU 6	150	28-Nov	SKU 4	2000
09-Nov	SKU 9	1	20-Nov	SKU 9	250	28-Nov	SKU 43	500
10-Nov	SKU 22	1000*	21-Nov	SKU 12	500	28-Nov	SKU 62	250
10-Nov	SKU 4	5	21-Nov	SKU 15	780	29-Nov	SKU 1	1
10-Nov	SKU 4	75	21-Nov	SKU 4	50	29-Nov	SKU 36	250
10-Nov	SKU 4	500*	21-Nov	SKU 4	1600	29-Nov	SKU 4	250
13-Nov	SKU 35	0.1	21-Nov	SKU 4	4800*	30-Nov	SKU 1	0.5
13-Nov	SKU 4	2000	21-Nov	SKU 56	4525			

* These products require extended testing of 168 hours or 7 days.

Exhibit 3 - Materials Inventory in 2010 (April 2010 – March 2011)

All quantities in Kilograms

Month	Pepper Receipts	Pepper Consumed	Pepper Closing Stock	SFG Produced	SFG Consumed	SFG Closing stock	FG Produced	FG Dispatch	FG Closing Stock
Mar-10			801118			14698			20548
Apr-10	311800	243780	869138	25597	30852	9443	34280	30236	24592
May-10	274259	264227	879169	27744	22834	14353	25371	26628	23335
Jun-10	417066	231001	1065234	24255	32598	6010	36220	31415	28140
Jul-10	379091	309592	1134733	32507	31779	6738	35310	39084	24366
Aug-10	288253	313557	1109429	32924	30484	9177	33872	33031	25207
Sep-10	242283	342704	1009008	35984	38480	6681	42756	30343	37619
Oct-10	213857	247568	975297	25995	30075	2600	33417	34257	36779
Nov-10	276840	235325	1016812	24709	24035	3274	26706	31122	32363
Dec-10	125332	315251	826893	33101	30796	5579	34218	33387	33194
Jan-11	578792	341015	1064670	35807	35651	5735	39612	36714	36092
Feb-11	109939	303627	870982	31881	32814	4802	36460	31221	41332
Mar-11	379499	365497	884984	38377	33418	9761	37131	30282	48181
Total	3597010	3513144		368880	373817		415353	387720	

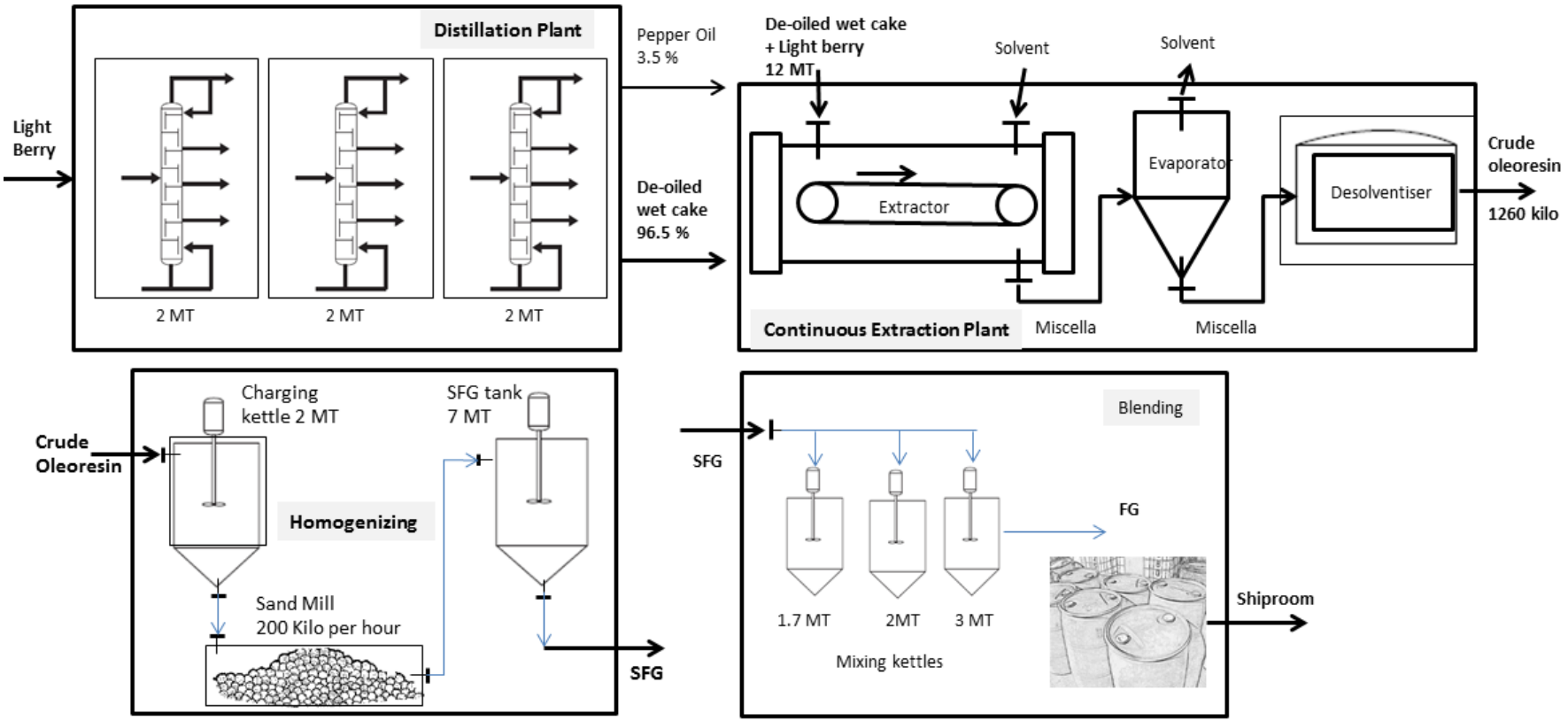
- Every 100 kilo of FG consumes only 90 kilo of SFG. The rest are oil and additives blended to bring it up to customer specs.

Exhibit 4 - Materials Inventory in 2011 (April 2011 - March 2012)

Month	Pepper Receipts	Pepper Consumed	Pepper Opening Stock	SFG Produced	SFG Consumed	SFG Closing Stock	FG Produced	FG Dispatch	FG Closing Stock
Mar-11			884984			9761			**48181**
Apr-11	190970	311166	764788	28556	**26471**	11846	29412	29269	**48323**
May-11	196285	318730	642343	35844	**9844**	37846	10938	21952	**37309**
Jun-11	340329	164029	818642	13319	**24965**	26201	27738	30000	**35047**
Jul-11	517920	316025	1020537	30517	**26025**	30693	28917	30628	**33337**
Aug-11	298739	416342	902934	35632	**30867**	35458	34297	39993	**27640**
Sep-11	136774	423876	615832	38018	**23931**	49545	26590	31632	**22599**
Oct-11	382848	199904	798776	21115	**38189**	32470	42433	48222	**16809**
Nov-11	581090	697143	682724	44188	**25779**	50880	28643	32907	**12545**
Dec-11	290831	405913	567641	34180	**42611**	42449	47345	42109	**17782**
Jan-12	337337	396742	508236	47522	**39536**	50435	43929	48774	**12937**
Feb-12	149150	332902	324484	43492	**27648**	66279	30720	35531	**8126**
Mar-12	92239	100863	315860	40840	**1440**	105679	35670	35670	**8126**
Total	3514512	**4083635**		**413224**	**317305**		**386632**	**426686**	

- Every 100 kilo of FG consumes only 90 kilo of SFG. The rest are oil and additives blended to bring it upto customer specs.

Exhibit 5 - Synthite Oleoresin Plant Schematic



Notes

Distillation process 6 MT raw material in 12 hours. Output is de-oiled cake (96.5% of input).
De-oiled cake is mixed with light berry to make a 75:25 mixture that is sent to extraction plant.
Extraction processes input at 500 kilo / hour. Outputs ~1260 kilo (~10.5% of input) crude oleoresin in 24 hours.
Charging kettle stirs and cools raw input lot for 10 hours
Sand mill homogenizes the lot in ~7 hours. The output is SFG.
SFG is stored in SFG tank where it is analysed and stirred for 4 hours after tank is full.
Based on customer order SFG is blended in the mixing kettles for 2-4 hours depending on volume. The output is FG.

Exhibit 6 - Quality Checks and associated Costs

#	QC Test	Cost	Duration
	Standard tests		
1	Oil test	Rs.75	6 hours
2	Piperine Test	Rs.75	1 hour
	Extended Tests **These are customer specified and FDA required tests**		
3	OC Test – Organochlorine –check for 17 pesticides coming under Organochlorine group	Rs.1,200	4 days
4	OP Test – Organo-phosphorous - check for 5 pesticides coming under Organo phosphorous group	Rs.1,200	1 day
5	Ochra toxin test	Rs.1,000	1 day
6	Alfa toxin test	Rs.1,250	1 day
7	Microbiology - check for different microbial parameters like Total Plate Count (TPC), Yeast & Mold (TYMC), E coli, and Salmonella.	Rs.720	TPC – 2 days TYMC – 7 days E.coli – 2 days Salmonella – 3 days
8	Residual Solvent analysis – check for the residue of the extraction solvent in oleoresin	Rs.150	2 hours

Exhibit 7 - Total QC Cost Calculation for 2011

Description	Calculation
SFG Level	SFG produced = 413224 kilo **(A)** SFG batch size = 1,260 kilo **(B)** # of SFG batches = A/B = 328
Standard Tests @ Rs.150 (Oil and piperine)	328 x Rs.150 = Rs.49, 200
Total Cost (at SFG level) (C)	**Rs.49,200**
FG Level	Number of shipments – 976 Oil and piperine tests on each shipment Other tests on 4 out of 10 shipments (on the average)
Standard Tests @ Rs.150 (Oil and piperine)	976 x 150 = Rs.1,46,400 **(D)**
Extended tests (required in 20% of shipments)	976 x 5520 x 2/10 = Rs.10,77,500 **(E)**
Total QC Cost (FY 11) (C+D+E)	**Rs.12,73,100**

Exhibit 8 - Mixing Kettle Data

	Kettle capacity (KG)	Blending Time for 1 MT or less (Hours)	Blending time at full capacity

			Hours / MT
Kettle 1	1700	1	2
Kettle 2	2000	1	3
Kettle 3	3000	1	4

Exhibit 9 - Blending capacity calculation (standard test products)

	Kettle capacity (kilo)	Loading Time (hrs)	Unload time (hrs)	Blending Time (hrs)	Testing Time* (hrs)	Total Time (hrs)	Capacity per hour (Kilo/hr)
Kettle 1	1700	2.43	2.43	2	6	12.86	132.22
Kettle 2	2000	2.86	2.86	3	6	14.71	135.92
Kettle 3	3000	4.29	4.29	4	6	18.57	161.54
						Total Capacity (per hour)	429.68

- Standard tests take six hours, blocking the kettle for that period.

Exhibit 10 - Blending capacity calculation (extended test products)

Kettle 1	Kettle capacity (Kilo)	Loading Time (hrs)	Unload time (hrs)	Blending Time (hrs)	Testing Time * (hrs)	Total Time	Capacity per hour (Kilo/hr)
Kettle 2	1700	2.43	2.43	2	168	102.86	16.53
Kettle 3	2000	2.86	2.86	3	168	104.71	19.10
	3000	4.29	4.29	4	168	108.57	27.63
						Total Capacity (per hour)	37.65

- Extended tests can take 1 to 7 days blocking the kettle for that period.
- Roughly, 20% of the shipments require one or more extended tests.
- Calculation is based on a typical case where extended tests require 4 days.

Exhibit 11 - Average Production Lead Times for High Volume Products (July 2010 – June 2011)

SKU	Avg Lead Time (Days)	STDEV OF Lead Time (Days)
SKU 01	19	11
SKU 04	12	21
SKU 05	30	11
SKU 06	20	13
SKU 07	20	8
SKU 09	15	29
SKU 10	20	14
SKU 11	49	40
SKU 22	20	8
SKU 26	42	
SKU 34	12	7
SKU 39	18	8
SKU 40	15	
SKU 44	20	20
SKU 56	29	20

Exhibit 12 - Average Inventory Days for FG Stock (July 2010 – June 2011)

Product	Inventory Days
SKU 04	73
SKU 09	65
SKU 01	54
SKU 26	53
SKU 10	36
SKU 15	72
SKU 05	142
SKU 34	75
SKU 03	23

Exhibit 13 - Number of changeovers / Cleanings

Product Variant	Calculations	
	SFG Level Cleaning (Charging kettle, sand mill, Pipelines)	**FG level Cleaning (Mixing Kettle)**
Decolorized pepper 10 SFG batches 25 shipments	10	25
White Pepper 1 SFG batch 15 shipments	1	15
No additive black pepper 5 batches 4 shipments	5	4
Total	16	44
Cleaning Cost		
Labour	8 man hours per cleaning = Rs.600 Rs.600 x 16 cleanings = Rs.9,600 **(A)**	3 man hours per cleaning = Rs.225 Rs.225 x 44 cleanings = Rs.9,900 **(B)**
Oil	1 kilo oil per cleaning = Rs.10,000 x 16 cleaning = Rs.1,60,000 **(C)**	1/2 kilo oil per cleaning = Rs.5,000 x 44 cleaning = Rs.2,20,000 **(D)**
Total Cost (A+B+C+D)	**Rs.3,99,500**	

Exhibit 14 - Rough Costs of Equipment

S.No.	Equipment	Cost
1	2 MT vessel	Rs.3,50,000
	2.5 MT kettle	Rs.4,25,000
2	3 MT vessel	Rs.4,00,000
3	5 MT vessel	Rs. 5,35,000
4	7 MT vessel	Rs.6,75,000
5	8 MT vessel	Rs.7,50,000
6	10 MT vessel	Rs.8,50,000
7	Sand mill	Rs.12,00,000
8	Pipeline (average length 25 meters per vessel)	Rs.50 per meter
9	Extraction plant	Rs.3,00,00,000
10	Distillation kettle (2 MT)	Rs. 3,50,000
11	Shed	Rs.25 per SFT

- Vessels are interchangeable. Any vessel can act like a charging kettle, SFG tank or mixing kettle.