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Research Note

A high yielding *seeragasamba* rice culture VG 09006 and its medicinal properties

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Abstract
The promising rice culture VG09006 was obtained from pedigree breeding by making crosses between ADT43 and *Seeragasamba* (traditional cultivar) at Agricultural Research Station, Vaigai dam during *kharif* 2007 by keeping ADT43 as female parent and *Seeragasamba* as male parent. The rice culture recorded an average yield of 6.15 t/ha which is 75% higher yield than *Seeragasamba*. The rice grain nutrient contents were analysed at Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu. The quality analysis of parboiled and milled rice has shown 5.1 % protein, 0.6% Fiber, 83.6 % Carbohydrate, 29.22% Amylose and 70.78% Amylopectin. The rice culture VG09006 will have a great potential in the field of diabetic studies in the years to come since high amylose content in the rice may have a much lower glycemic load.

Key Words: *Seeragasamba*, traditional rice, ß-Sitosterol, antioxidant, squalene

Rice, *Oryza sativa* (2n=24), an important cereal crop of this world belongs to the kingdom *Plantae*, division *Magnoliophyta*, class Liliopsida and family *Poaceae*. It is the second important cereal crop in production. Rice is the hope of life since it caters the food requirement for more than half of the global population. It is cultivated in an area of 164.1 million hectares with a total production of 722.8 million tones. In Asia, rice is cultivated in an area of 145.3 million hectares with 653.2 million tonnes of production. India had produced 155.7 million tonnes of paddy in 44.1 million hectares. China ranks first in production with 202.6 million tonnes (FAOSTAT, 2013).

Rice was first domesticated about 8000 years ago independently in southern China and north eastern India. The conscious and unconscious selection by humans led to the development of over 1,50,000 varieties grown around the world (Khush,1987). Rice forms the life and a means to livelihood in Asia (Swaminathan, 2012). 'Rice is Life' since it is consumed by 2/3rd of world population and atleast for half of them; it is the main source of energy in the diet. As early as 2800 BC, Royal Chinese physicians used rice for medicinal purposes. Chinese believed that rice strengthens the spleen as well as stomach, increases appetite and cures indigestion (Umadevi *et al*., 2012).

Rice is an integral part of Indian culture with everything starts and ends with rice, from birth to death. Rice is first mentioned in the Yajur Veda (1500-800 BC) and then is frequently referred to in many Sanskrit texts. According to Dr. R.H. Richharia, eminent rice scientists of the world, 4,00,000 varieties of rice probably existed in India during the Vedic period and 2,00,000 varieties of rice exist now in India (Thiyagarajan and Biksham Gujja, 2012) shows the richness of rice diversity for all seasons and all reasons.

India's population is predicted to grow approximately 1.5 billion by 2030 and overtake china (Katiyar, 2012). As climate change has made frequent floods and prolonged droughts, the modern high yielding rice varieties and hybrids suffer most due to the erosion of its biodiversity and increase of mono-cropping in agriculture. The significant characteristics of some of the traditional varieties are their medicinal, nutritional traits and their consumer preferences. The present investigation was carried out to evolve a new variety with the intention of deriving quality grain from the traditional paddy variety *Seeragasamba* and keeping yield and yield attributing characters of ADT43.

Selection of Parents: The objective of this research was to evolve a high yielding superfine paddy for special food purposes like briyani, khuska and variety rices like tomato rice, coconut rice and pongal which fetches premium prices to farmers and also to have an alternative variety to traditional rice *Seeragasamba.* Parents *viz*., ADT43 and *Seeragasamba* were chosen for crossing. Among them ADT43 is a cross derivative of IR50 / White ponni, which is preferred for *kuruvai* season sowing having medium slender grain with 110 days duration with a potential yield of 5.75t/ha. The other parent *Seeragasamba* is a traditional cultivar which is preferred for *samba* season (September sowing) with 140 days duration having small fine grain with an average yield of 3.0 t/ha. *Seeragasamba* can not tolerate high chemical fertilizer applications and lodging at the time of maturity is a problem. However, it fetches premium price for its grain and aroma, since it is regularly used for making mutton briyani dishes.

The crossing was effected between ADT43 and *Seeragasamba* at Agricultural Research Station, Vaigai dam during *kharif* 2007 by keeping ADT43 as female parent and *Seeragasamba* as male parent. The sowing of parents was adjusted to have synchronized flowering for effecting crosses between them. The F_1 was intermediate in height (117 cm) but with 36 productive tillers, which is higher than both the parents. The grain size is smaller than the ADT 43 and comparable with *Seeragasamba*. In F_2, 497 plants were obtained with transgressive segregation. Huge variations were noticed for plant height, grain shape and size, grain colour and maturity periods. Segregating generations derived from the above crosses were subjected to pedigree method of breeding. Two crops were taken in a year. The following criteria were taken in to account for plant selection in the segregating populations *viz*., medium height (85-95 cm), more productive tillers (25 and above), pest & disease tolerance, small size grain with medium duration. Individual plant selection was continued till the progenies become virtually homozygous and they show no segregation. The promising culture among the population is VG-09-006 (6^{th} culture selected in the year 2009 from ARS, Vaigai dam). Presently F_8 generation is available and their seeds were bulked for further seed multiplication and analysis at Indian Institute of crop Processing Technology (IICPT), Thanjavur, Tamil Nadu. A replicated yield trial was conducted for the culture VG09006 along with BPT 5204, *Seeraga samba* and CO49 during *Rabi* 2012-13. Randomized Block Design was followed with 3 replications. The spacing adopted was 25 x 15 cm in a 5 x 4m plot size.

GC-MS Analysis: In the present study, the parent's *viz*., ADT 43 is a non-aromatic and *Seeragasamba* is a well known traditional aromatic rice was used for crossing. So the aim of undertaking GC-MS analysis was to ascertain the presence of aroma compound if any in the new rice culture VG 09006. Representative samples (500 gm) of hand pounded rice were submitted for analysis. Hand pounded rice was taken for analysis since it is being extensively used for making mutton dishes. Hand pounding was done through conventional method. Initially, the outer husk was removed and through subsequent 2 to 3 hand poundings the outer brown bran layer was also removed and made the rice bright coloured.

GC-MS analysis was carried out at Indian Institute of Crop Processing Technology (IICPT), Thanjavur, Tamil Nadu. It was carried out on a GC Clarus 500 Perkin Elmer system and gas chromatograph interfaced to a mass spectrometer (GC-MS) instrument employing the following conditions: Column Elite-5MS fused silica capillary column (30mm×0.25mm×0.25 µm df, composed of 5% Diphenyl / 95% Dimethyl poly siloxane), operating in electron impact mode at 70 eV; Helium (99.999%) was used as carrier gas at a constant flow of 1ml/min and an injection volume of 2 µl was employed (split ratio of 10:1); Injector temperature 250°C; Ion-source temperature 200°C. The oven temperature was programmed from 110°C (isothermal for 2 min.), with an increase of 10°C/min, to 200°C, then 5°C/min to 280°C, ending with a 9 min. isothermal at 280°C. Mass spectra were taken at 70 eV; a scan interval of 0.5 seconds and fragments from 45 to 450 Da. Total GC running time was 36 minutes.

Interpretation on mass spectrum GC-MS was conducted using the database of National Institute Standard and Technology (NIST) version-year 2005. The spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library.

Traditional variety *Seeragasamba* is raised mostly in the Uppiliyapuram panchayat union of Thuraiyur taluk of Trichi district of Tamil Nadu, India. Uppiliyapuram is well known for its soil fertility and water source from Ahayagangai fountain of Kolli hills (Sathyamoorthi, 2013). The primary aim of the present study was to evolve a high yielding *Seeragasamba* rice to fetch premium price to the farmers. The culture VG09006 is a derivative of the cross between ADT 43 (non-aromatic) and *Seeragasamba* (aromatic). It recorded the maximum yield in the yield trial at station. It yields 9.8% higher than CO 49, 34.87% higher than BPT 5204 and 75.71 % higher than traditional *Seeragasamba* rice (Table 1). This culture can be cultivated throughout the year in the paddy growing tracks of Tamil Nadu and even it can withstand intermittent drought at their critical stages. The plant type, grain type and field view are shown in Fig. 1 to 2. The salient feature of the paddy culture VG09006 is furnished below:

Days to 50 % flowering	:	95 days
Days to maturity	:	135 days
Plant Height	:	92 cm
No. of productive tillers	:	26.4
Yield	:	6150 kg/ha
1000 grain weight	:	8.90 g (at 10.70% moisture content)
Special Features	:	➢ Tolerant to pest and disease incidence. ➢ Drought tolerance. ➢ Can be cultivated throughout the year.

The rice grain dimension (uncooked rice), protein, carbohydrate, amylose and amylopectin contents were analyzed at IICPT, Thanjavur and the results are furnished in Table 2. The parboiling process

has increased not only the rice amylose content from 23.10 % to 29.22 % but also the fiber content from 0.2 to 0.6%, which is a desirable feature.

The retention time and chemical composition of phyto-components is presented in Fig.3 and Table 3 for hand pounded rice. While analyzing the representative sample of the rice culture VG09006 for its aroma compound through GC-MS analysis, a lot of saturated fatty acid derivatives belonging to n-Hexanoic acid ($C_6H_{12}O_2$), n-Dodecanoic acid ($C_{12}H_{24}O_2$), n-Octadecanoic acid ($C_{18}H_{36}O_2$) and n-Eicosanoic acid ($C_{20}H_{40}O_2$) were observed. The lipid content especially sterols accounts for 22.26% peak area in the hand pounded raw rice. The presence of aromatic dicarboxylic acid compound *viz*., 1,2-Benzenedicarboxylic acid, diisooctyl ester, diterpene compound Geranyl-linallol, triterpene compound Squalene, and aromatic phytosterol ß-Sitosterol observed in rice may contribute for the pleasant aroma. In hand pounded raw rice, the major component was 1,2-Benzenedicarboxylic acid, diisooctyl ester (19.41%) closely followed by ß-Sitosterol (19.19%). The other important components are Diglycidyl ether, Heptacosane and Nonadecane, 2-methyl. The compounds identified by GC-MS shows the biologically active compounds with pharmaceutical value. It is summarized in the Table 4.

The traditional *Seeragasamba* rice is meant to be eaten along with meat dishes (Community Protocol, 2010). The reason could be due to the presence of ß-Sitosterol in the rice grain , which inhibits the cholesterol absorption in the intestine and rather they are secreted in the stool. This way ß-Sitosterol makes their way out of the body pulling cholesterol with them. The benefits of ß-Sitosterol are countless (Balanced Health Today, 2013). The quality analysis of rice has shown 5.1 % protein , 0.6% Fiber, 83.6 % Carbohydrate, 29.22% Amylose and 70.78% Amylopectin in parboiled and milled rice; 5.1 % protein , 0.2% Fiber, 83.2 % Carbohydrate, 23.10% Amylose and 76.90% Amylopectin in the hand pounded rice. The parboiling process has increased the rice amylose content and also the fiber content from 0.2 to 0.6%, which is a desirable feature. Presence of ß-Sitosterol and higher amylose content in the hand pounded rice has shown its anti-diabetic nature. The higher amylose content has a much lower glycemic load, which favours slower rate of digestion. Slow digestion properties of starch lead to slower glucose release and lower glycemic response (Wikipedia, 2013). In addition to anti-diabetic properties, the GC-MS analysis had also shown the presence of other pharmaceutical compounds especially anti-oxidants and Central Nervous System activating compounds. So this new rice culture VG09006 may have a remarkable role in the near future. The results of GC-MS analysis have to be confirmed with the clinical studies.

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References

Achiraman, S. and Archunan, G. 2006. 1-iodo-2methylundecane, a putative estrus-specific urinary chemo-signal of female mouse (*Mus musculus*). *Theriogenol.*, **66:** 1913- 1920.

Balanced Health Today. 2013. *http://www.balancedhealthtoday.com/Beta-sitosterol-Supplements.html*

Benyhe,S., Márki, Á., Corina Nachtsheim, Ulrike Holzgrabe and Anna Borsodi.2003. Kappa-receptor selective binding of opioid ligands with a heterocyclic bicyclo[3.3.1]nonan-9-one structure. *Acta Biologica Hungarica* ,**54** (2): 147–155.

Charothon Jindarom, Vissanu Meeyoo, Thirasak Rirksomboon, Boonyarach Kitiyanan and Pramoch Rangsunvigit. 2006. The production of Bio-oil by Oxidative Pyrolysis of Sewage Sludge in Rotating Fixed Bed Reactor. *As. J. Energy Env.* 2006, **7**(4): 401-409.

Community Protocol. 2010. Community Protocol of Sirkazhi Organic Farmer Association in Tamil Nadu, India. pp.4.

Dhew (NIOSH) Publication No. 78-166 . 1978. Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers. Appendix V- Reactivity of the Glycidyl Ethers. Department of Health, Education, and welfare , Ohio, USA. pp. 18 .

FAOSTAT. 2013. Statistical databases. *http://www.fao.org*

Katiyar,S.S. 2012. *Everyman's Sci.,* **47**(1): Indian Science Congress Association, Kolkatta. p.3.

Khush,G.S. 1987. Rice breeding: Past, Present and Future. *J.Genet.*,.**66**(3):195-216.

Ogunlesi, M., Okiei,W. and Osibote, A.E. 2009. Analysis of the essential oil from the dried leaves of *Euphorbia hirta* Linn (Euphorbiaceae), a potential medication for asthma. *Afr. J. Biotechnol.* **8**(24):7042-7050.

Ping Sun, Xiangchao Cheng and Honghao Yu. 2012. Urinary Olfactory Chemosignals in Lactating Females Show More Attractness to Male Root Voles (*Microtus oeconomus*), Gas Chromatography - Biochemicals, Narcotics and Essential Oils, (Ed.)Dr. Bekir Salih . pp 236.

Priya,V., Jananie, R. K. and Vijayalakshmi, K. 2011. GC/MS determination of bioactive components of *Trigonella foenum- graecum*. *J. Chem. Pharm. Res*., **3**(5):35-40

Rameshwar Naidu, J., Ismail, R. B., Chen Yeng, Sasidharan, S. and Kumar, P. 2012. Chemical composition and antioxidant activity of the crude methanolic extracts of *Mentha spicata*. *J. Phytol*., **4**(1): 13-18.

Sathya, S., Srisudha, S. and Gunasekaran, P. 2012. Growth Rate, Pigment Composition and Fatty

Acid Profile Of *Chlorella pyrenoidosa*. *International J. Biol. & Pharmaceutical Res.*, **3**(5): 677-683.

Sathyamoorthi,G. 2013. Seeraga samba in the clutch of drought. The Hindu Daily Newspaper dt.2.2.2013.

Sinead O'Mahony Carey, 2010. Psychoactive Substances. A Guide to Ethnobotanical Plants and Herbs, Synthetic Chemicals, Compounds and Products. pp 375. (*http://www.drugs.ie/resourcesfiles/guides/Psychoactive_substances_low_res.pdf*)

Sungbeom Lee, Somayesadat Badieyan, David R. Bevan, Marco Herde, Christiane Gatz, and Dorothea Tholl. 2010. Herbivore-induced and floral homoterpene volatiles are biosynthesized by a single P450 enzyme (CYP82G1) in Arabidopsis. Proceedings of the National Academy of Sciences. (*www.pnas.org/cgi/doi/10.1073/pnas.1009975107*)

Swaminathan, M.S. 2012. Transforming Rice Production with SRI (System of Rice Intensification) Knowledge and Practice. Authored by T.M. Thiyagarajan and Biksham Gujja. National Consortium of SRI (NCS), Hyderabad, India. pp 216.

Thiyagarajan, T.M. and Biksham Gujja . 2012. Transforming Rice Production with SRI (System of Rice Intensification) Knowledge and Practice. National Consortium of SRI (NCS). Hyderabad, India. pp.216.

Umadevi,M., Pushpa,R., Sampathkumar,K.P. and Debjit Bhowmik. 2012. Rice-Traditional Medicinal Plant in India. *J. Pharmacognosy and Phytochem.*,**1**(1): 29-36.

Wikipedia. 2013. *http://en.m.wikipedia.org*

Table 1. Performance of culture VG 09006 during rabi 2011-12 at station trial

Culture/ Varieties	Plant Height (cm)	No. of Productive Tillers	Grain yield (kg/ha)
VG09006	92	26.4	6150
BPT 5204 ©	93	15.5	4560
Seeragasamba ©	110	14.7	3500
CO 49 ©	95	14.9	5600
S.E	3.0	1.1	300
C.D.(P=0.05)	10.2	3.8	1039
C.V.(%)	5.3	10.6	10

Table 2. Quality parameters of culture VG09006

Sample	L (mm)	B (mm)	L:B	T (mm)	Protein (%)	Fiber (%)	Carbohy-drate (%)	Starch (%)	Amylose (%)	Amylo-pectin (%)
Parboiled & milled rice	3.63	1.9	1.91	1.25	5.1	0.6	83.6	62.40	29.22	70.78
Hand pounded rice	3.63	1.93	1.88	1.23	5.1	0.2	83.2	66.14	23.10	76.90

Table 3. Chemical composition of hand pounded rice culture VG09006

RT	**Name of the compound**	**Molecular formula**	**MW**	**Peak Area %**
7.67	Diglycidyl ether	$C_6H_{10}O_3$	130	14.14
18.37	Eicosane	$C_{20}H_{42}$	282	1.43
19.79	2-Bromo dodecane	$C_{12}H_{25}Br$	248	4.39
20.32	1,2-Benzenedicarboxylic acid, diisooctyl ester	$C_{24}H_{38}O_4$	390	19.41
21.20	Heptadecane, 2-methyl-	$C_{18}H_{38}$	254	6.80
22.60	Heptacosane	$C_{27}H_{56}$	380	8.99
23.98	Nonadecane, 2-methyl-	$C_{20}H_{42}$	282	7.13
24.14	Squalene	$C_{30}H_{50}$	410	2.96
25.34	Heptadecane, 2,6,10,15-tetramethyl-	$C_{21}H_{44}$	296	5.92
26.69	1-Iodo-2-methylundecane	$C_{12}H_{25}I$	296	3.84
29.04	Cyclohexane, (2-ethyl-1-methylbutylidene)-	$C_{13}H_{24}$	180	1.10
30.32	1,6,10,14-Hexadecatetraen-3-ol, 3,7,11,15-tetramethyl-, (E,E)-	$C_{20}H_{34}O$	290	3.07
31.49	ß-Sitosterol	$C_{29}H_{50}O$	414	19.19
33.11	Bicyclo[3.3.1]nonan-9-one, 1,2,4-trimethyl-3-nitro-, (2- endo,3-exo,4-exo)-(.+-.)-	$C_{12}H_{19}NO_3$	225	1.64

Table 4. Chemical constituents and their applications

Name of the compound	Chemical classification	Applications/ Remarks
Diglycidyl ether	Epoxy ether	Glycidyl ethers are very reactive biologically and utilized for tumor inhibition because of their alkylating properties (Dhew [NIOSH] Publication, 1978).
Eicosane	Alkane	Eicosane constituents is observed in Guggul Tree (*Commiphora mukul*) and Lavender (*Lavandula angustifolia*) having a major role in mental alertness and reducing stress (Sinead O' Mahony Carey, 2010).
2-Bromo dodecane	Alkane	Similar compounds reported in *Chlorella pyrenoidosa* (Sathya *et al*., 2012) . Dodecane compounds are present in Gotu kola (*Centella asiatica*), which is one among the different compounds for alertness, refreshing, relaxing, increased concentration, and for reducing anxiety& stress (Sinead O' Mahony Carey, 2010) .
1,2-Benzenedicarboxylic acid, diisooctyl ester	Aromatic-Dicarboxylic acid	Treatment of asthma and function as a repellent against *Anopheles* species (Ogunlesi *et al*., 2009).
Heptadecane, 2-methyl-	Alkane	Antioxidant activities. Rameshwar Naidu *et al*. (2012) reported that the antioxidant activity of spearmint may be due to the presence of flavonoids and fatty acid methyl esters (hexa decane, hepta decane, octa decane) which has the scavenging potential by reducing the free radicals.
Heptacosane	Alkane	Heptacosane is in Lavender (*Lavandula angustifolia*) and Raspberry (*Rubus idaeus*) having their role as energizer , mental alertness and reducing stress (Sinead O' Mahony Carey, 2010).
Nonadecane, 2-methyl-	Alkane	Nonadecane compounds are present in Guggul Tree (*Commiphora mukul*), Lavender (*Lavandula angustifolia),* Skullcap (*Scutellaria galericulata), etc.* having their prime role in CNS depressant rejuvenating and relaxes nervous system (Sinead O' Mahony Carey, 2010).
Squalene	Triterpene	Anticancer, Antimicrobial, Antioxidant, Chemo- preventive, Pesticide, Anti-tumor and Sunscreen (Priya *et al.,* 2011).
Heptadecane, 2,6,10,15-tetramethyl-	Alkane	Antioxidant activities.
1-Iodo-2-methylundecane	Alkane	An estrus-specific urinary chemosignal of female mouse (*Mus musculus*) (Achiraman and Archunan , 2006). The variation in urinary volatiles might be influenced by the endocrine system. The urine of lactating females is more attractive to males than that of non-lactating females in Root Vole. (Ping Sun, 2012).
Cyclohexane, (2-ethyl-1-methylbutylidene)-	Alkane	Similar compound 1-Tridecyne was reported in the bio-oil obtained from sewage sludge (Charothon Jindarom *et al*., 2006).
1,6,10,14-Hexadecatetraen-3-ol, 3,7,11,15-tetramethyl-, (E,E)-	Tertiary alcohol/Di-terpene	Synonym is Geranyl- linallol. Attractants for pollinators or exert defensive activities against herbivores, thereby contributing to plant survival and reproductive success (Sungbeom Lee *et al*., 2010).
ß-Sitosterol	Aromatic-Phytosterol	Phytosterol which inhibits cholesterol absorption in the intestine. Hypercholesterolemia treatment. Herbal therapy for benign prostatic hyperplasia in Europe (Wikipedia, 2013).
Bicyclo[3.3.1]nonan-9-one, 1,2,4-trimethyl-3-nitro-, (2- endo,3-exo,4-exo)-(.+-.)-	Opioids	Central Nervous System (CNS) stimulant, antidepressant, reduce anxiety & stress, rejuvinates CNS (Sinead O' Mahony Carey, 2010). Fits with the structure of ketazocine, a prototypic kappa selective benzomorphan compound (Benyhe *et al*., 2003).

Fig.1. Individual Plant VG09006

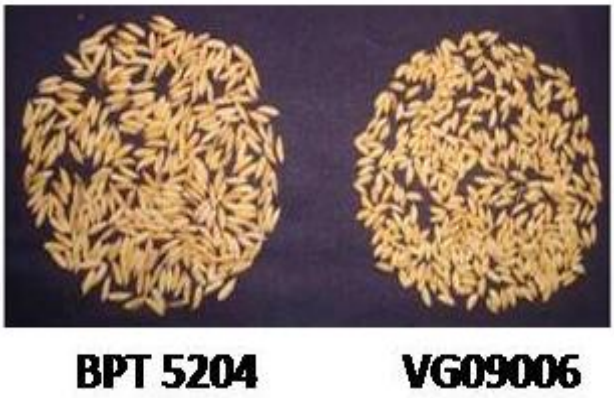

Fig.2. Grain comparison

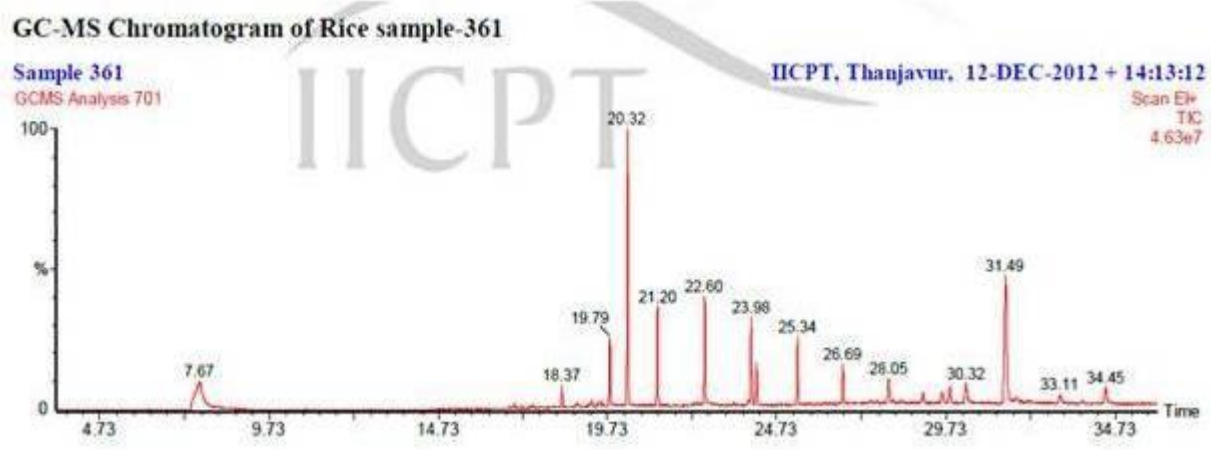

Fig.3. Chromotogram of hand pound rice