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Study on variation of qualitative characteristics of seeds and oil content in *Pongamia pinnata* L. Pierre (Honge) an important biodiesel tree

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Abstract
The preliminary study was taken up to understand the variation on qualitative characteristics of seeds and oil content in *Pongamia pinnata in* different rainfall zones in Hasssan district of Karnataka. The study was carried out in three contrasting locations represented by 20 random trees from each location. Accordingly, the observations were collected on Seed Biomass and Fatty acid composition (kernel oil) were studied to know the pattern and extent of variation among the rainfall habitats. The results revealed significant variation among the rainfall habitats. The moisture content was found to be highest in high rainfall (15.93%) and least in low rainfall area (9.55%). In case of low rainfall area, between Arasikere and Channarayapatna population, the fresh weight of seeds is higher in case of Arasikere seed population shows higher fresh biomass (4.30±0.500) than in case of Channarayapatna (3.80±0.65). In contrast to this, seed dry weight parameter shows the lower value in Arasikere population (3.35±0.46) than that Chnnarayapatna (3.58±0.39) though there is no significant difference. While the moisture content is higher in case of Chnnarayapatna (10.60±0.94) than in case of Arasikere seed population (8.50±0.83).
The fatty acids varied significantly along the three rainfall zones of the study area. The highest content of the palmitic acid (12.04%), stearic acid (6.03%), oleic acid (8.84%), stearic acid (5.36%) was detected in low rainfall Zone followed by medium rainfall Zone except for the for oleic acid and the lowest content of all this chemical component were detected in the high rainfall Zones. This evidently shows that Arsikere lies in the transition zone produces quality seeds for bio diesel production.

Keywords: variation, qualitative characteristics, seeds, *Pongamia pinnata* L, biodiesel tree

Introduction

"Energy", the basic requirement of all human activities, it is harvested both from renewable and non-renewable sources, such as fossil fuel, solar, wind, hydroelectric, nuclear energy, etc. However, major source of worlds energy supply is from the non-renewable fossil fuels, which include petroleum, coal, and natural gases. The planet is going through a tough phase of global warming with CO_2 levels raising from 280 ppm in 1960 to almost 411.84 ppm in 2020 (Dangerous Levels Beyond 450 ppm) while it was 180 ppm in ice age (Friedlingstein *et al.*, 2019) [4]. The fossil fuels are over exploited and renewable fuels such as biofuels (Biodiesel and Bioethanol) and other alternative energy sources are to be promoted. They play an extremely important role in solving energy crisis of the world.

There are many non-edible oil crop crops such as Jatropha (*Jatropha curcas*), Polanga (*Calophyllum inophyllum*), Karanja (*Pongamia pinnata*) and Neem (*Azadirachta indica*) were also found to be promising as alternative biodiesel feedstocks. Among them *Pongamia pinnata* (L.) is one such important tree species. *Pongamia pinnata* (L.) Pierre (Family Fabaceae – Papilionoideae) is native to India and commonly known as karanja (Mukta and Sreevalli, 2010).

Trees can also play a vital role in rural economy by generating employment during various stages of its cultivation, harvesting as well as during downstream processing. In recent days, it is gaining worldwide attention because most of the physical and chemical properties of seed oil are like those of diesel, though the carbon residue' is higher (Bala *et al.*, 2011) [2].

Material and Methods

Study Area

Hassan district was selected to document the *Pongamia pinnata* population, considering the diverse habitats, altitudinal range, rainfall regimes and associated crops in the agro ecosystems; stratified sampling was followed considering the administrative hierarchy of the habitat, Taluk, Hobli, Village. Geographically the study area falls between $75^0 33'$ - $76^0 38'$ E longitude and $12^0 31'$ - $13^0 33'$ N latitude with an altitude ranging from 150 m (near Kalgunda village of Dakshina Kannada) to 1,389 m (Genkalbetta) above MSL. Total geographical area of the district is 6,814 Sq. km.

Site selection and sampling

Seed sample of pongamia was collected in three rainfall regimes in the district, *viz*., region 1 - High rainfall, region 2 - Medium rainfall and region 3 - Low rainfall region. The region-wise specific survey was conducted for the collection of seed samples during the harvesting periods (April to June 2015–2016).

Tree selection

Two locations were selected from each rainfall regime and 10 trees with an average age of 20 years were selected randomly per location. Trees were selected by considering different sites *viz*., 1. Agricultural land, 2. Roadside / open space / Forest area and 3. Near household. Geo-coordinates of all the selected random trees are in the map depicting the sites of collection are furnished in the Fig 1.

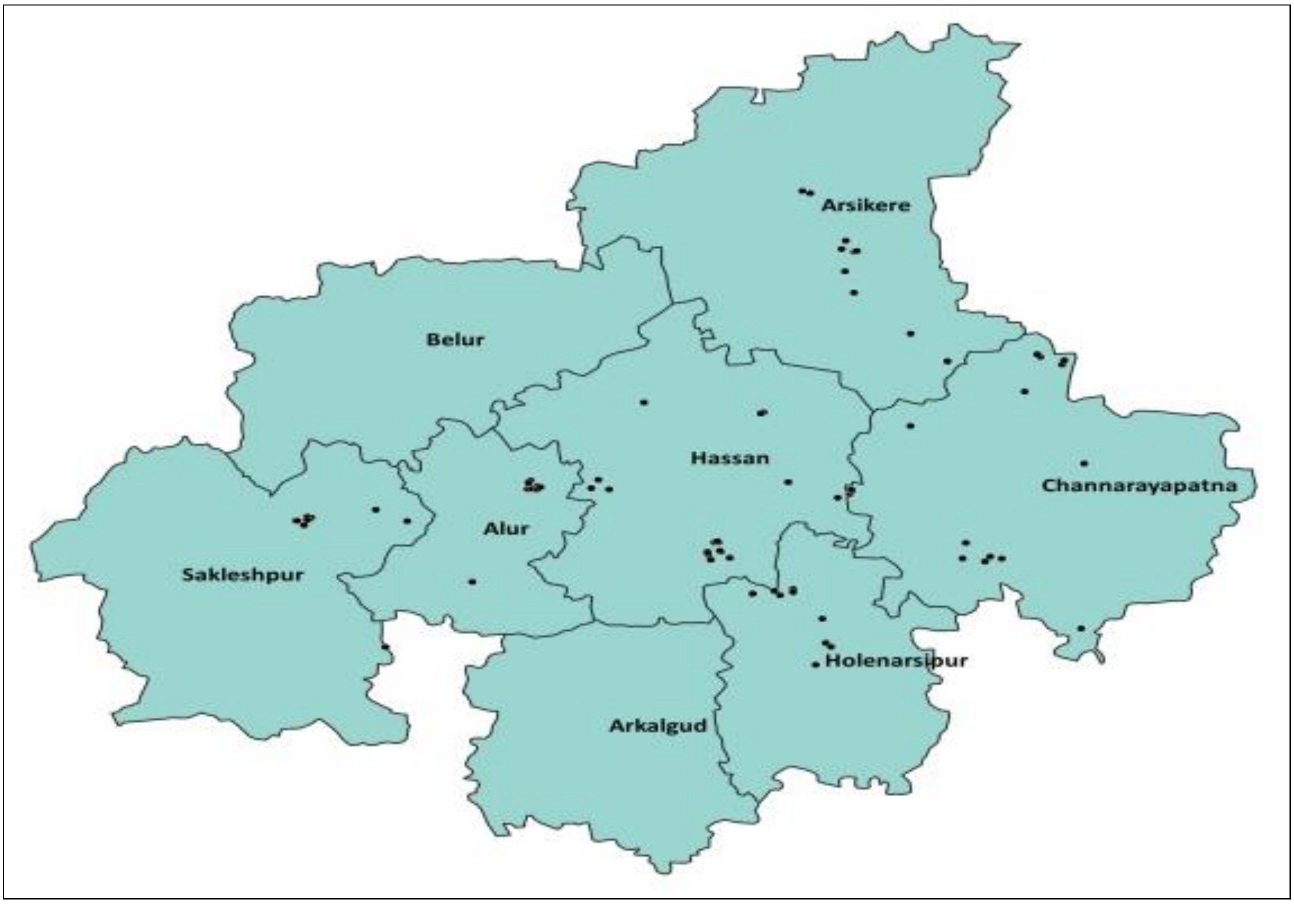


Fig 1: Geo coordinates of the randomly selected trees in the study area.

Pod and seed collection

During the survey it was noticed that the seed-bearing season varied among different seed sources. Based on the seed availability at different times, pods with seeds intact were collected from the selected trees from all the location of the trees with geocoordinates selected for the study to carry out the present investigation.

Determination of fatty acid composition

The fatty acid profiling (Palmatic acid, Stearic acid, Oleic acid and Linoleic acid) composition of the seed oil was determined using an Agilent series Gas Chromatograph (GC) EN14103.

Statistical Analysis

The experimental data thus obtained during investigation were subjected to statistical analysis by applying the technique of one-way analysis of variance (ANOVA) to test the significance of overall differences among the treatments.

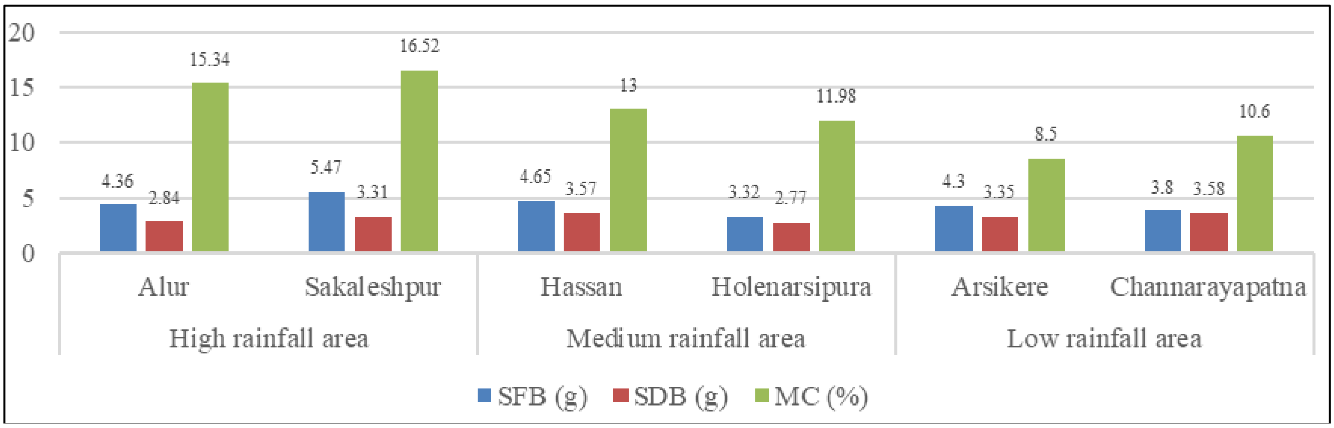
Results and Discussion

The results pertaining to the seed biomass in different rainfall habitat in *Pongamia pinnata* in Hassan district is furnished in the below table no 1 and graph.

Table 1: Seed Biomass in different rainfall regime in *Pongamia pinnata* in Hassan district.

Regions		**SFB (g)**		**SDB (g)**		**MC (%)**	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
High rainfall area	Alur	4.36	0.35	2.84	0.56	15.34	0.86
	Sakaleshpur	5.47	0.43	3.31	0.85	16.52	0.36
Medium rainfall area	Hassan	4.65	0.29	3.57	0.69	13.00	0.27
	Holenarsipura	3.32	0.34	2.77	0.53	11.98	0.65
Low rainfall area	Arsikere	4.30	0.50	3.35	0.46	8.50	0.83
	Channarayapatna	3.80	0.65	3.58	0.39	10.60	0.94

Note: SFB: Seed fresh biomass, SDB: Seed dry biomass, MC: Moisture content



Seed oil content and its biochemical parameters in the different rainfall zones

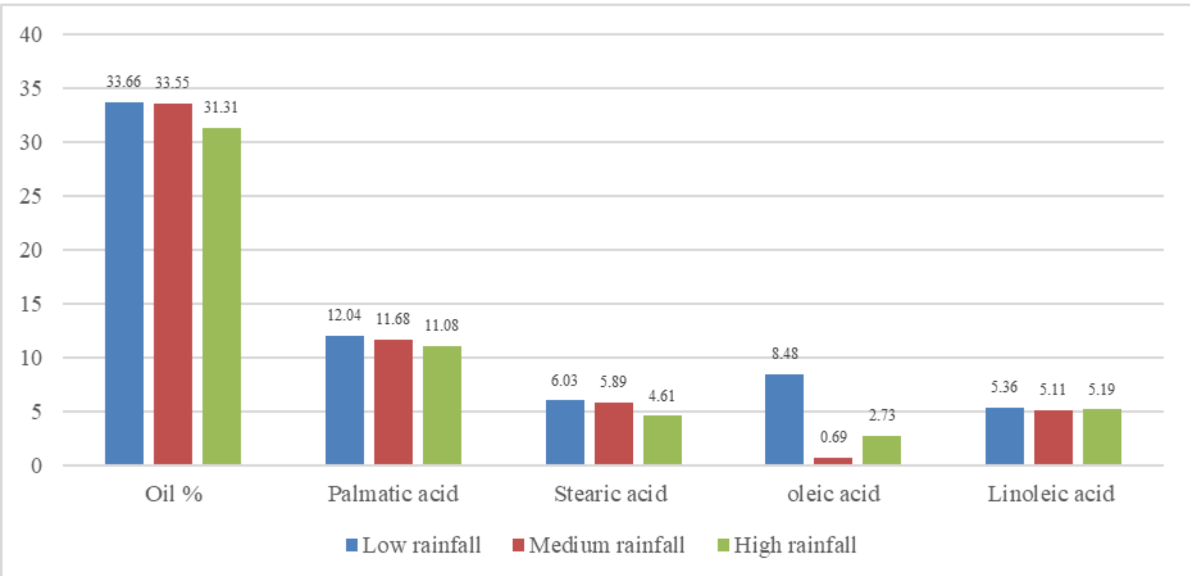
In case of low rainfall area, between Arasikere and Channarayapatna population, the fresh weight of seeds is higher in case of Arasikere seed population shows higher fresh biomass (4.30±0.500) than in case of Channarayapatna (3.80±0.65). In contrast to this, seed dry weight parameter shows the lower value in Arasikere population (3.35±0.46) than that Chnnarayapatna (3.58±0.39) though there is no significant difference. While the moisture content is higher in case of Chnnarayapatna (10.60±0.94) than in case of Arasikere seed population (8.50±0.83). However, seed biomass is not significantly higher in Arasikere population indication both the sources are on par with respect to selection of seeds. Variation in the moisture content is due to climatic factors such as rainfall, humidity and number of rainy days. Joshi *et al*. (2015) [6] reported that the moisture content of Mesua was 31 per cent. These results are on par with the results in the present study.

The results of qualitative analysis of oil from seeds of *Pongamia pinnata* are shown in tables 2. Around ten fatty acid components were detected in the Pongamia oil, of which four were well identified as the major compounds in the *P. pinnata* oil. The major chemical components were oleic acid, palmitic acid, linoleic acid and stearic acid.

Table 2: Seed oil content and its biochemical parameters in the different rainfall zones

Parameters	Oil %	Palmatic acid	Stearic acid	Oleic acid	Linoleic acid
Low rainfall	33.66	12.04	6.03	8.48	5.36
Medium rainfall	33.55	11.68	5.89	0.69	5.11
High rainfall	31.31	11.08	4.61	2.73	5.19
	S	S	S	S	S

Note: S - Significant



Seed oil content and its biochemical parameters in the different rainfall zones

Major fatty acids varied significantly along the three rainfall zones of the study area. The highest content of the palmitic acid (12.04%), stearic acid (6.03%), oleic acid (8.84%), stearic acid (5.36%) was detected in low rainfall Zone followed by medium rainfall Zone except for the for oleic acid and the lowest content of all this chemical component were detected in the high rainfall Zones.

Similar findings are also reported in other oils *viz*., Pongamia and Mahua in the previous studies (Sanjib and Anju, 2005; Ghadge and Raheman, 2006; Mohibbe *et al*., 2005) [10, 5, 8]. The fatty acid composition of *P. pinnata* oil was in good agreement with the previous studies (Kushwah *et al*., 2008) [7]. The Pongamia seed oil predominantly contains four fatty acids, namely, palmitic, stearic, oleic and linoleic acid. In addition to these major fatty acids, its oil also contains very less amounts of linolenic, behenic and eicosenoic acid. Oleic acid is the major fatty acid among pongamia trees and generally constitute about half of the oil with a range from approximately one to two thirds (Arpiwi *et al*. 2012; Sunil *et al*. 2009) [1, 11]. This different fatty acid composition at different rainfall regimes might be because of variation in species or different ecological conditions, because local edaphic and environmental factors are of crucial importance to the growth and characteristics of a particular plant, including the richness and uniqueness of the germplasm; they also impart characteristic traits specific to a region (Folch *et al*., 2010).

From the above results it was found that *Pongamia pinnata* is potential biodiesel yielding tree species most suitable for the low rainfall zone but also it performs well in the medium and high rainfall Zone. The oil yield and biodiesel quality was found high in low rainfall Zones when compared with the high and medium rainfall Zones. Hence it has been proposed for the all the regimes for the production of pongamia oil as raw material for the biodiesel.

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