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Study on effect of coir dust on pulmonary disorders in coir industries of Odisha

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Abstract
Odisha enjoys 450 km of sea coast and coconut is cultivated in 0.50 lakh hectares with a productivity of 7300 kg nuts per ha. The total operations for making yarn from green or dry coconut is a very drudgerious operation done generally with semi mechanized mills with noisy and dusty conditions creating a non-workability area for operation. The amount of dust produced from the machines during operation is much high than the recommended value of respirable dust concentration. The study showed that a major per cent of workers suffer through various diseases such as respiratory problems, pulmonary fibrosis and even lung disorders if exposed for a long time. The concentration as well as time of exposure and the quality of the dust influences the frequency and the type of clinical syndrome in coir workers.

Keywords: Coir dust, pulmonary disorder, spirometer, forced expiratory volume (FEV) forced vital capacity (FCV)

Introduction
Cocos nucifera L. is being largely cultivated in Philippines, Indonesia, India and Sri Lanka. Among the major coconut producing countries, India has emerged as a premier coconut producer in the world and its annual production is about 12 billion nuts from an area of 1.9 million ha. More than 90 percent of the coconut is grown in the states namely Kerala, Karnataka, Tamil Nadu Andhra Pradesh and Odisha Mathew (2004) [6]. R. Srinivasan (2011) [8] on coir-the golden fibre concluded that the coir industry employs more than 650,000 persons, of whom majority are from rural areas belonging to the economically weaker Sections of the society. Nearly 80 per cent of the coir workers in the fibre extraction and spinning sectors are women. Evans and Konduru (1996) [4] studied on source variation in physical and chemical properties of coconut coir dust. Most of the particles in the coir dust sources were from pith tissue (particles < 8 mm) and were between 0.5 and 2.0 mm in diameter. Abad *et al.* (2005) [1] studied the physical properties of various coconut coir dusts compared to peat. They found that Coir dust was evaluated as a light weight material, and its total porosity was above 94 per cent (by volume).
The coir fibre making process is very drudgerious work which is generally done in a noisy and dusty environment leading to health-related disorders. Health problems consists of illness, water blisters, burning of eyes, headache and injuries, respiratory disease such as nasal infection and throat infection, musculoskeletal disorders such as sprain, back pain. The major setback is the issues which rise from the coir dust leading to pulmonary related disorders. Particle size of coir dust varies depending on the work task from which they are generated. Working in an environment with coir dust leads to inhalation of the particles through the respiratory tract, causing health effects when the coir particles are deposited and come in direct contact with the tissue covering the respiratory tract. Spirometry is the most widely used lung function test in the world. It is fundamental in diagnostic and functional evaluation of various pulmonary diseases. It plays a significant role in the diagnosis and prognosis of these diseases and describes the effect of restriction or obstruction on the lung function. In view of the fact that various airborne particulate dusts puts the worker's health into jeopardy and most of the workers in India do not use protective measures and no earlier study in this sector has been reported, this study was undertaken to assess the effect of coir dust exposure on pulmonary functions of workers.

Materials and Methods
The study was conducted in three coir industries located in Madhipur, Nirmala and Mangalpur area all belonging to the Puri district of Odisha due to its high presence in the eastern coastal

region of Odisha (latitude of 20° 123' N and longitude of 85° 80' E and an elevation of 45 m above mean sea level) in 2016-17. The subjects taken comprised of 9 female subjects categorized into 3 age groups in case of controlled and 15 female subjects categorized into 5 groups on the basis of their exposure to the duration of exposure to dust (1-3 years, 4-6 years, 7-9 years, 10-12 years, 12-15 years). These workers work for nearly 5-6 hours a day for 6 days a week. In case of controlled subjects a detailed history including that of smoking and general physical examinations was done. Persons having chronic infections of lungs, asthma and persistence cough were excluded from our study for healthy group. The anthropometric parameters such as age, height, weight were assessed and pulmonary function tests were performed in resting stage.

A spirometer was used to determine whether the workers working in the coir industry are prone to any respiratory problems or not. Spirometers may be used to classify participants as normal, having an obstructive pattern and/or a restrictive pattern. Specifically, a low Forced Vital Capacity (FVC) is indicative of a restrictive disorder, and typically these individuals will also have a low Forced Expiratory Volume (FEV_1). A low FEV_1/FVC % ratio may indicate an obstructive impairment. On average, typically 70-80 percent of the FVC is exhaled in the first second from a person who is healthy. However, a person with airway obstruction may be able to exhale only 60 percent or less of the FVC in the first second even though the FVC may be normal. Additionally, some persons may show evidence of a combination of both airway obstruction and restrictive disease.

This instrument along with COSMED software installed in the laptop helps in determining FVC, FEV_1, (FEV_1/FVC) %, PEFR, FEV%, SVC, MVV. The subjects were made to sit in a chair with hands placed upon its legs and in an upright position and forbidden to lean. A nose clip was provided to prevent respirations through the nostrils during the experiment. The mouthpiece of the spirometer was placed and tightly sealed by lips of the subjects and was instructed to blow out air only through mouth for a duration of at least 6 seconds. This practice was continued for three times to get an accurate result.

Results and Discussion

The Pulmonary Function Test (PFT) was conducted by the help of spirometer in order to know about the respiratory related disorders in the coir industry. Table 1 shows the parameters such as age, height, weight, BMI, Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV_1) and (FEV_1/ FVC) % undertaken for the test to carry out. Three controlled group of age approximately 22, 35 and 48 each comprising of 3 members were initially tested to determine the standard of test.

Table 1: Pulmonary Function Test (PFT) of controlled group

Parameters	Control 1	Control 2	Control 3
Average age	22	35	48
Height cm	161	168	158
Weight kg	50	72	68
BMI kg/m2	19.28	25.51	27.24
FVC litre	4.44	4.38	4.20
FEV_1 litre	3.36	3.30	3.22
FEV_1/FVC (%)	75.7	75.3	76.66

Table 2: Pulmonary Function Test (PFT) of coir workers

Duration of exposure (years)	Average FVC (L)	Average FEV_1 (L)	Average FEV_1/ FVC (%)
1-3	3.69	3.02	81.80
4-6	3.49	2.92	83.97
7-9	3.40	2.90	85.02
10-12	2.81	2.46	87.50
13-15	2.61	2.32	88.88

In table 2. three persons from each working experience of 1-3 years, 4-6 years, 7-9 years, 10-12 years and 13-15 years consisting a total of 15 persons were selected who were associated with coir industries. The average FVC, FEV_1 and (FEV_1/FVC) % value was measured. According to Global Initiative for Obstructive lung disease,

If FEV_1/FVC> 85%, then Restrictive lung disease (pneumonia, TB, lung cancer)

If FEV_1/FVC<70%, then Obstructive lung disease (COPD, asthma, bronchiolitis)

The Pulmonary Function Test (PFT) conducted above says that the experience group of 1-3 years and 4-6 years are slowly getting affected by restrictive lung disease. The experience group of 7-9 years has entered the recommended ratio for restrictive lung disease. The working group having experience of 10-12 years and 13-15 years are in serious trouble as they have surpassed the recommended safe limit and are probably suffering from restrictive lung disease. The results indicate that there is a gradual increase in the average (FEV_1/FVC) % with the working experience of the workers. This proves that working in the coir industry gradually makes the workers prone to respiratory disorder. Figure1 and Figure 2 below indicates that there is a decrease in the FVC as well as FEV_1 with the dust exposure duration in industries.

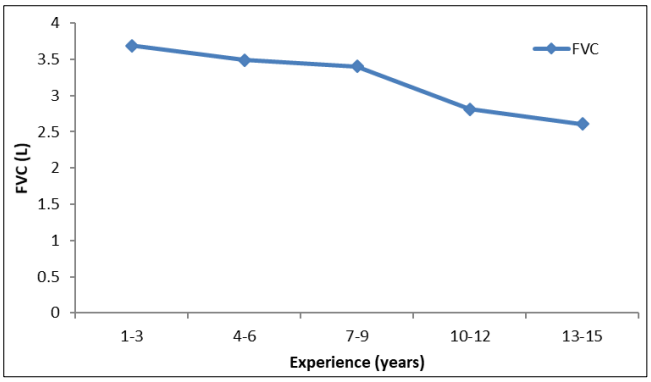

Fig 1: Effect of dust exposure duration (years) on FVC

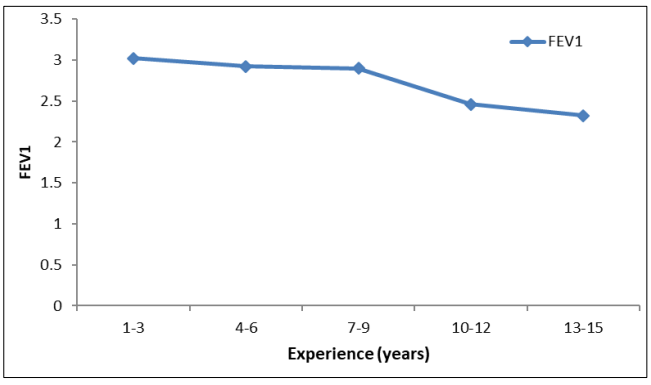

Fig 2: Effect of dust exposure duration (years) on FEV_1

The Pulmonary Function Test (PFT) was conducted to know about the respiratory related disorders in the coir industry. The FVC, FEV_1 and (FEV_1/ FVC) % were undertaken for a controlled group and the same were tested with the coir industry workers. It was found that the (FEV_1/ FVC) % increased as their working experience increased making them prone to respiratory disorders. Workers with occupational respiratory disease may develop permanent breathing problems, becoming disabled, and unable to work. This not only affects individual workers, but has wider cost implications for employers and the grain industry as a whole. The occupationally related lung diseases are most likely due to the deposition of dusts in the lung and are influenced by the sort of dusts, period of exposure, the concentration and size of air borne dusts in the breathing region. Not only the workers but also the community living nearby areas breathes dust mixed air in to their lungs everyday which reduces the quality of life. The workers working in these industries suffer from various types of air way diseases. Dust particles which are inhaled and lodged in the lung irritate and set up an inflammatory reaction. Healing of this inflammatory reaction causes fibrosis leading to defective oxygen diffusion and impaired lung function.

The results are in close agreement with Dhillon and kaur (2011) who researched on study of effect of flour dust and rice husk dust on pulmonary functions. On comparison it was found that there was highly significant (p<0.001) decline in FVC, FEV_1 and MVV in rice mill workers as compared to flour mill workers. The values of respiratory parameters goes on decreasing with increase in number of years of exposure to rice husk and flour dust. Dewangan and Patil (2015) [2] also studied on evaluation of dust exposure among the workers in agricultural industries in North-East India. Respirable dust were 8.22, 5.76, 2.98, and 6.34 mg/m^3 and total dust exposure were 81.05, 111.02, 56.68, and 39.85 mg/m^3 in the rice mills, oil mills, flour mills, and tea factories, respectively. They found out that the workers are exposed to a very high level of respirable and total dust. They found that the distributions of workers according to occupational illness and injury faced by the men and women workers are: burning of eyes (92.8%), burning of face (95.27%), eye irritation (92.8%), fatigue (90.4%), headache (92.8%). Pranav and Biswas (2016) [7] studied on mechanical intervention for reducing dust concentration in traditional rice mills. They observed that the developed system is successfully collects the significant amount of dust and able to reduce the dust concentration up to 58%.

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