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# STUDIES ON BACTERIAL INDICATORS OF FAECAL POLLUTION IN DRINKING WATER



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**Abstract:** The objective of the study was to compare the routinely used bacterial indicator systems of faecal pollution, the coliforms and faecal coliforms with faecal streptococci and spores of sulphite reducing anaerobes (Clostridia) to assess their importance in determining the bacterial quality of water. A total of 84 samples of water from the Kandy distribution system of water were tested. Percentage of samples that were found to be contaminated by the three indicators, coliforms, faecal coliforms and faecal streptococci are 37%, 15% and 54% respectively. It was found that the use of faecal streptococci to determine faecal pollution of treated tapwater has additional advantage over the presently used coliform, faecal coliform indicator systems. Results of the use of *Clostridium* spores in determining the hygienic quality of water was found to be unsatisfactory.

## 1. Introduction

The search for an adequate indicator of faecal contamination in water has logically been associated with organisms common to the microbial flora of faeces Prerequisites for the ideal indicator have restricted the probable candidates to total coliforms, faecal coliforms, faecal streptococci and *Clostridium perfringens.*[7] Of these, coliforms and faecal coliforms are routinely used.

There are well known epidemiologic histories of the presence of bacterial pathogens when the coliform index was low. Boring *et al*[1] reported that *Salmonella typhimurium* outnumbered coliforms by a factor of 10 in the River Side California Outbreak. Similarly a report by Sleigman and Reitter[16] showed that index organisms can be low in the presence of pathogens. Isolation of *Salmonella* from drinking water which fullfilled the bacterial standards with regard to coliforms have been reported.[12] The reports of the failure of the index organism concept emphasize the need for more research that compare different indicator systems that could be used as indices of faecal pollution of drinking water.

Different opinions exist worldwide with regard to the question whether streptococci should be regarded as an indicator of faecal pollution. This poor acceptance of faecal streptococci as a measure of pollution from human and warm-blooded animal excreta has been a result in part of low recovery rates, of the multiplicity of detection procedures of poor agreement between the detailed and systematic studies of the sources, survival and interpretation of streptococci in various kinds of water. [5, 6, 14, 15] The use of *Clostridium perfringens* as a supplementary indicator in addition to the routine examination in potable water has also been proposed,[4] although it is not used routinely.

This paper reports the results of the application of faecal streptococci together with the routinely used indicators of faecal pollution coliforms and faecal coliforms in the determination of bacterial quality of drinking water. In addition, detection and enumeration of the spores of sulphite reducing anaerobes has been attempted in the present study, based on the working paper for a draft proposed for a draft international standard of *Clostridia* spores by the International Standardisation Organisation (ISO/TC/147/SC4/WG/5N41E).

## 2. Experimental

### 2.1 Collection of Samples

A total of 84 samples of tap water from the Kandy distribution system were examined during the period March 1982 to June 1983. All the samples were collected from street standposts which are directly connected to the mains and transported in accordance with the methods recommended by the WHO.[17] Examination of the samples were carried out within 3 hours of sampling.

### 2.2 Bacteriological Analysis

#### *2.2.1 Enumeration of faecal streptococci*

Hundred ml of the sample was concentrated on a 0.45 $\mu$ millipore filter and the filter was placed on the surface of a petridish containing KF streptococcus agar (Merck 10707). The plates were incubated at 37° C for 40 hours and the maroon or pink colonies were counted.

#### *2.2.2 Enumeration of Clostridium perfringens spores*

The samples of water were heated for 10–20 minutes at 70° – 75°C. Hundred ml of this preheated sample was filtered through a 0.45 $\mu$ millipore

filter and the filter was transferred with face upwards to the bottom of a petridish. Ten ml of liquefied sulphite-glucose-iron agar[3] which has been cooled to about 50°C was carefully poured over the membrane filter. After this layer of agar has set, incubated aerobically at 37°C for 24–48 hours and all the black colonies were counted.

*2.2.3 Enumeration of total and faecal coliforms*

Most probable number technique was used according to the WHO recommendation.[17]

**2.3 Isolation of *Salmonella***

Ten litre samples of tap water were concentrated using the membrane filtration technique. The filters were incubated in a pre-enrichment broth[8] at 37°C for 16 hours. From this a drop was transferred to Preuss K tetrathionate broth (Merck No. 5173) and lactose saccharose agar (Merck No. 7237) at 37°C was followed from Preuss tetrathionate broth. Suspicious colonies were subjected to biochemical reactions according to Cowan and Steel [3] and serology was performed.

## 3. Results

**3.1 Faecal streptococci**

Of the 84 samples of water that were tested 46 samples (54%) were found to be positive for faecal streptococci. The count of faecal streptococci ranged from 1– 360/100 ml.

**3.2 *Clostridium perfringens***

Growth of *Clostridium perfringens* was observed only in 3 samples out of 84 samples of water that were tested.

**3.3 Total and faecal coliforms**

Thirty-one samples (36.9%) were positive for total coliforms by the most probable number technique. Twenty samples (23%) contain more than 10 coliforms/100 ml. Thirteen samples out of the 31 (41.9%) that were positive for total coliforms were confirmed for the presence of faecal coliforms. Of the samples, 15% were positive for faecal coliforms from the total samples examined. Both the total and faecal coliform densities range from 2 to 1600/100 ml.

### 3.4 Salmonella species

*Salmonella* was isolated from 4 samples out of the 84 samples that were examined (4.8%). The counts of coliforms, faecal coliforms and faecal streptococci in the 4 samples in which *Salmonella* was recovered were 79, 70, 12, 2/100 ml, 33, <2, <2, <2 and 45, 8, 11 and 3/100 ml respectively.

### 3.5 Safety of water with regard to different indicator systems

The proportions of samples that can be considered safe by the indicator coliforms (53/84) and faecal coliforms (71/84) are significantly higher (at the 5% level) than that obtained by faecal streptococci (38/84).

## 4. Discussion

The method used in the present study in determining the number of faecal streptococci has been to isolate streptococci from Lancefield's serological group D (ISO/TS/147/5C, 4G4). It has been shown that these faecal streptococci are more persistant than coliforms under natural conditions.[13] In the present study too, the proportion of samples that can be considered Safe by the coliform faecal coliform indicator system is significantly higher than faecal streptococci. This shows that the recovery rate of faecal streptococci by the use of the method recommended by the International Standardisation Organisation is much higher than coliforms with the most probable number technique. This could be due to the greater resistance of faecal streptococci to the purification processes as reported by Cohen and Shuwal.[2] The faecal coliform measurement is said to relate more precisely to faecal contamination by warm blooded animals.[7] In the present study, *Salmonella* was isolated from 10 litre samples of water without the detection of faecal coliforms by the routinely used most probable number technique. But faecal streptococci was detected in all 4 samples in which *Salmonella* was recovered. Therefore by having a specific standard for faecal streptococci a higher degree of purity and sense of security could be attained than the presently used indicator system coliform/faecal coliforms.

Results obtained in the use of *Clostridium* spores as an indicator of faecal pollution of water was not satisfactory in the present study.

In conclusion it can be said that it is advantageous to use faecal streptococci in addition to total and faecal coliforms in determining the pollution of treated water.

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# EFFECT OF SODIUM MECLOFENAMATE ON FERTILITY OF MALE RATS

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**Abstract:** Chronic local administration of sodium meclofenamate, a prostaglandin synthesis blocking drug, to epididymis of rats via silicone rubber rods (3.5 mm dia. and 10 – 12 mm length) containing 50% drug produced an irreversible suppression in fertility. This effect was accompanied by a reduction in libido, ejaculatory competence, motility of epididymal sperm and the weights of seminal vesicles and coagulatory glands. Furthermore, mild to moderate necrosis in tunica vaginalis and scrotal sacs was evident. However, a lower dose (25% rods) failed to induce any significant change in fertility nor did it produce any of the above undesirable side effects.

## 1. Introduction

Prostaglandins are present in vasa deferentia and epididymides of several species [4, 8] including the rat.[7, 10] Although the precise role of prostaglandins in epididymal function is unknown, it is suggested that they are involved in regulation of their spontaneous contractions,[7] orgasmic contraction [11, 12] and processes of maturation of sperm within it.[14] It should therefore be possible to alter fertility potential of males by prostaglandin synthesis blocking drugs. Indeed, a reduction in fertility of male rats has been demonstrated with chronic local application of aspirin, a prostaglandin synthesis blocking drug to epididymis.[15] However, the antifertility efficacy of aspirin in this study was found to be low. The present study was therefore, undertaken to investigate the effects of a therapeutically more potent prostaglandin synthesis blocking drug, sodium meclofenamate when administered locally to epididymis of rats. Sodium meclofenamate (Meclomen ® ; N-(2,6-dichloro-m-tolyl) anthranilic acid, sodium salt, monohydrate; Warner-Lambert Co., U.S.A.) is the most potent known inhibitor of prostaglandin synthesis in synthetase systems of mammalian origin.[9]

## 2. Experimental

### 2.1 Animals

Healthy adult laboratory bred mixed strain rats of proven fertility (males weighing 275 – 300g and females weighing 200 – 225g) were used. They were housed in a well ventilated animal house at a temperature of 28 – 30°C with a natural photoperiod (approximately 12h. light and 12h. dark daily). All rats had free access to food (rat pellets, Moosajees Ltd., and green leaves) and tap water.

### 2.2 Construction of sustained-release drug delivery system

Silastic formulations containing 25% and 50% sodium meclofenamate were prepared in the form of rods (3.5mm, dia. and 10 – 12mm, length) by mixing known weights of powdered sodium meclofenamate and polysiloxane polymer (silastic 382, Medical Grade Elastomer, Dow Corning Corp. Midland, Michigan, U.S.A.) in a pestle and mortar, followed by the addition of the curing agent (stannous octoate). The resulting homogeneous mixture was expressed from a 5 ml disposable syringe into polythene tubing and allowed to set. Control rods consisting entirely of silastic were also prepared.

### 2.3 Insertion of rods to epididymis

Insertion of rods was made under mild ether anaesthesia using aseptic precautions. A rod containing 50% sodium meclofenamate (13 rats), or 25% sodium meclofenamate (6 rats) or a drug-free rod (10 rats) was placed adjacent to each epididymis via an incision made in the scrotal sac and in the tunica vaginalis of each side as described in detail elsewhere.[16] The day of insertion of rod was designated as day O.

### 2.4 Assessment of fertility

Libido, ejaculatory competence and fertility of the operated animals were tested on day 3 and 7 and then approximately at weekly intervals for 2 months by pairing each male overnight with a pro-oestrous female, which had had a regular 4 day vaginal cycle. Insemination was confirmed by the presence of spermatazoa in the oestrous vaginal smear on the following morning (between 7.00 and 8.00 a.m.). If spermatazoa were present their numbers in the vagina were estimated. In the absence of spermatozoa daily vaginal smearing of the females was continued to check pregnancy or pseudopregnancy. At 8 – 10 days post coitum, the females were laparotomized and the number of embryos present in each uterine horn was counted.

### 2.5 Motility of epididymal spermatozoa

Motility was assessed in a separate series of experiments with 6 rats, each of which was fitted with one 50% sodium meclofenamate rod adjacent to one epididymis and one drug-free adjacent to contralateral epididymis. At day 7, these rats were anesthetized and spermatozoa from a portion of the cauda epididymis were extracted into saline (NaCl 9g/l) and their motility graded on a subjective scale from 0 (immotile) to 5 (greatest motility ever observed). In addition, these spermatozoa were examined microscopically (x 400) for major abnormalities.

### 2.6 Reproductive organ weights and pH determinations

Six rats were fitted with a single 50% sodium meclofenamate rod adjacent to each epididymis and 6 with a single drug free rod adjacent to each epididymis. On day 7, the animals were killed, weighed and their testes, epididymidis, vasa deferentia, seminal vesicles and coagulatory glands were excised, defatted, blotted free of any blood and weighed separately on a Mettler analytical balance. The weights of these organs are represented as a percentage of body weight. Equal weights of seminal vesicle of the treated and the control rats were then homogenized with 10 ml distilled water and pH of these were assessed using a Beckman pH meter.

### 2.7 Autopsy

On day 60, all survivors (26 rats) were sacrificed and their gastrointestinal tract and reproductive systems were examined grossly for any abnormalities. The 3 rats which died on day 3 were also subjected to an identical procedure.

### 2.8 Nerve-induced mechanical response of isolated vasa deferentia

In 6 rats, vasa deferentia were rapidly removed under mild ether anaesthesia and carefully cleaned from loose connective tissue and fat. The preparations were mounted at 1.0g tension in a 50 ml organ bath maintained at $37 \pm 1°C$ in a physiological salt solution of the following composition (mM/l). $Na^+$, 143; $K^+$, 5.8; $Ca^{++}$, 2.6; $Mg^{++}$, 1.2; $Cl^-$, 128; $H_2PO_4^-$, 1.2; $HCO_3^-$, 25: $SO_4^{--}$, 1.2 and glucose 11.1. The solution in the organ bath was continuously bubbled with 5% $CO_2$ in $O_2$. Contractions were elicited by transmural stimulation through platinum ring electrodes using SRI stimulator for 5 sec at a frequency of $5H_z$ with impulses of 0.5m. sec duration and 90V and recorded ismoterically on a Bioscience pen recorder. Sodium meclofenamate was then added cumulatively, increasing the concentration every

15 min. and response to electrical stimulation was recorded at each dose studied (2, 10, 20, 50 or 100 $\mu$ g/ml). Contractile response in the presence of drug were expressed as a percentage reduction of the organs response to transmural stimulation prior to drug addition.

### 2.9 Release rate from 50% sodium meclofenamate rods

A single weighed 50% sodium meclofenamate rod was fitted adjacent to each epididymis of 6 rats. These rods were removed on day 8 and dried at 60°C until a constant weight was reached. The quantity of drug released during this period was estimated by substracting the final weight from the initial weight. The release rate was then computed assuming a constant release profile from the rod. However, this is, at best, an approximate estimation.

## 3. Results

During the study, 3 rats fitted with 50% sodium meclofenamate rods died; the first on day 2 and the others on day 3. The cause of death appears to be drug-related as autopsy revealed lesions representing gastrointestinal intolerance and peritonitis. These 3 rats were excluded from the present study. The general appearance of the majority of the remaining animals was normal as was evident by their behavioural responses and undiminished food and water intake. However, 6 rats fitted with 50% sodium meclofenamate rods developed, between day 20 – 35, mild to moderate bilateral necrosis in the areas of tunica vaginalis and scrotal sacs adjacent to the site of implantation of the rod.

### 3.1 Assessment of fertility

The 50% sodium meclofenamate rods caused a marked impairment of libido as was indicated by complete absence of spermatozoa in vaginal smears and by the absence of the pseudopregnant state of the females paired with treated males ; 19 out of 58 pairings did not result in successful mating. In contrast, in 25% sodium meclofenamate and control groups successful mating took place in 26 out of 30 and 87 out of 88 pairings respectively. Furthermore, at successful matings, the vaginal sperm counts of 50% sodium meclofenamate group was less than 0.1 million, while that of 25% sodium meclofenamate and control groups exceeded 5 million.

The fertility of the 25% sodium meclofenamate and control groups was unimpaired throughout the study as indicated by the normal complement of embryos (6 – 11) in the females with which they were paired. On the other hand, in 50% sodium meclofenamate group, fertility was reduced in

Table 1. Summarized data showing the effect of on fertility (fertility index) of sodium meclofenamate-containing silastic rods placed adjacent to epididymis. Values in parantheses are number of males successfully mated at each serial pairing. Results are expressed as mean ± s.e.m.

| Treatment group | Fertility index | | | | | | |
|---|---|---|---|---|---|---|---|
| | Time after implantation of rods | | | | | | |
| | Days | Weeks | | | | | |
| | 3 | 1 | 2 | 3 | 5 | 7 | 8 |
| Control rods | 9.5 ± 0.5 (6) | 8.5 ± 0.6 (6) | 9.1 ± 0.6 (6) | 8.0 ± 0.4 (6) | 8.3 ± 0.6 (6) | 8.2 ± 0.2 (5) | 8.0 ± 0.7 (6) |
| Sodium meclofenamate 25% rods | 8.0 ± 0.7 (5) | 6.8 ± 0.8 (5) | 7.2 ± 0.5 (4) | 7.8 ± 0.5 (6) | 8.3 ± 0.3 (6) | | |
| | ** | ** | ** | * | ** | * | * |
| Sodium meclofenamate 50% rods | 1.2 ± 0.3 (4) | 2.8 ± 1.1 (6) | 3.7 ± 0.9 (8) | 4.0 ± 1.1 (8) | 0.8 ± 0.5 (6) | 3.5 ± 1.3 (4) | 1.6 ± 1.0 (5) |

** $P<0.01$

* $P<0.05$

all animals; no embryos were detected in 19 pairings while low numbers (3 – 7) were observed at 21 pairings. The fertility was restored to normal level only in one animal in this treatment group. These data are summarized by calculating at each time interval, the fertility index, where fertility index = total number of embryos/number of successful matings at that time interval. The summary Table 1 shows that there is a significant reduction in the fertility index of animals treated with 50% sodium meclofenamate (Mann-Whitney test, $P<0.05$).

### 3.2 Motility of epididymal spermatozoa

The average motility score of sperm on the treated side was 2.50 ± 0.22 (mean ± s.e.m.) and that on the control side was 4.67 ± 0.21. This difference was statistically significant ($P<0.05$, Mann-Whitney test). Further, there were no major morphological abnormalities in spermatozoa of the treated side.

### 3.3 Reproductive organ weights and pH measurements

The average weights of testes, epididymidis, vasa deferentia, seminal vesicles and coagulatory glands and pH of seminal vesicular homogenate of 50% sodium meclofenamate treated rats were 1157 ± 33mg, 450 ± 33mg, 99 ± 08mg, 229 ± 34mg and 33 ± 04 mg and 6.37 ± 0.04 respectively. In the control rats, corresponding values were 1089 ± 40mg, 420 ± 20mg, 83 ± 07mg, 394 ± 32mg and 93 ± 27mg and 6.4 ± 0.09. A significant reduction in the weights of seminal vesicles ($P<0.02$) and coagulatory glands ($P<0.05$) was evident with Student unpaired t-test.

### 3.4 Autopsy

The 3 rats that died during drug treatment (50% rods) had gastric and intestinal lesions. Ulceration of gastrointestinal tract as a side effect has been reported in rats following chronic oral administration of sodium meclofenamate in high doses.[20] The cauda epididymidis of rats with 50% sodium meclofenamate rods were distended and 5 animals had developed bilateral spermatic granulomas. The vasa deferentia, on the other hand, were devoid of any sperm granulomas. In contrast, the abdominal viscera and reproductive organs of 25% sodium meclofenamate and control group appeared normal and no granulomas were observed in the epididymidis and vasa deferentia. Furthermore, the silastic rods in all rats remained adjacent to epididymidis without much displacement from their original positions.

### 3.5 Nerve-induced mechanical response of isolated vasa deferentia

The vasa deferentia responded to nerve stimulation by eliciting an initial rapid 'twitch' (amplitude, 3.4 ± 0.25g) and secondary sustained contraction (amplitude, 1.23 ± 0.15g) as reported by other workers.[2, 18] As shown in Table 2 sodium meclofenamate significantly depressed both components of the response, from above 10 $\mu$ g/ml ($P<0.05$, paired t-test).

Table 2: Effect of sodium meclofenamate on the isometric longitudinal response to nerve stimulation. Responses are expressed as a percentage reduction of pre-drug control mean ± s.e.m. (N = 10 – 12)

| Concentration of drug ($\mu$g/ml) | Response ( % reduction ) | |
|---|---|---|
| | Twitch | Secondary |
| 2 | 7.1 ± 4.8 | 9.3 ± 1.5 |
| 10 | 42.2 ± 5.5 | 44.0 ± 10 |
| 20 | 46.6 ± 7.1 | 56.8 ± 6.2 |
| 50 | 44.3 ± 6.1 | 48.6 ± 8.5 |
| 100 | 56.0 ± 6.7 | 64.2 ± 4.1 |

### 3.6 Release rate from 50% sodium meclofenamate rods

The average rate of release of drug per day from 50% sodium meclofenamate rods was 8.4 ± 0.6mg.

## 4. Discussion

The results of the present study show that chronic insertion of silastic rods containing 50% sodium meclofenamate rods adjacent to epididymis of rats caused a reduction in fertility and libido. Both these effects were permanent throughout the period of study. A lower dose of drug (25% rods), neither suppressed fertility nor libido. In contrast, aspirin when applied locally to epididymis of rats has been shown to reduce fertility with no concomitant reduction in libido.[15]

Several factors may have contributed for the antifertility effect observed in the study, but the production oligospermic ejaculates is probably the principal factor. At the initial phase (up to about 21 days) of the study, such an effect could have resulted from an impairment of ejaculation, which is consistent with the observation that sodium meclofenamate reduced

considerably nerve-induced contractions of isolated vasa deferentia. Moreover, in therapeutic doses, naparoxen, another prostaglandin synthesis blocking drug has been reported to cause impairment of ejaculation in men.[19] In view of the present method of administration and high release rate of drug (approximately 9mg/day) injury or physiological changes in the nerves and smooth muscle of the epididymis may occur. This too may have contributed, to the production of oligospermic ejaculates as disturbances in ejaculatory phenomenon is reported with injury or alteration of the nerves and muscles supplying the ejaculatory system.[19] Infertility at subsequent stages could have resulted from an impairment in spermatogenesis or due to blockage of sperm transport from mechanical occlusions in the epididymal tubules by the sperm granulomas which were evident in majority of the animals treated with 50% sodium meclofenamate. The former mechanism is unlikely as prostaglandin synthesis inhibitors promote spermatogenesis[1] and prostaglandins suppress spermatogenesis.[1] The lack of restoration of fertility in treated males (50% rods) can be attributed to sperm granulomas in cauda epididymis, as it is known that sperm granulomas impair fertility permanently.[3] There is no conclusive evidence about the mechanism/s responsible for the reduction in libido observed in the study, but it is likely to be due to a reduction in androgen output from testes since a significant depression in wet weights of seminal vesicles and coagulatory glands was observed. Male libido [13] and structural and functional integrity of sexual accessory glands are androgen-dependent.[5, 13] At later stages of study (after day 20) in particular, physical trauma arising from drug-induced lesions in the tunica vaginalis and in scrotal sacs may have been partly responsible for the suppression in libido as it is known that discomfort at site of sperm granulomas occur during sexual excitement of ejaculation[17] and that stress, physical or mental, decline sexual drive in men.[6] In addition, it is likely that impairment of sperm motility together with a change in biochemistry of semen and fertilizing potential of sperm may have played a substiantial role in inducing the observed antifertility effects. Alteration in semen biochemistry and fertilizing capacity of ejaculated sperm but not in sperm numbers or sperm motility has been suggested as possible mechanism for antifertility recorded with local application of aspirin to epididymis.[15]

In conclusion, this study provides confirmation that prostaglandin synthesis inhibiting drugs reduce fertility of male rats when administered locally to epididymis, previously shown with aspirin.[15] Further, although aspirin and sodium meclofenamate are both prostaglandin synthesis inhibitors bringing about antifertility effects in male rats, it becomes evident that they operate via different mechanisms.

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# EVALUATION OF A MASTITIS CONTROL PROGRAMME ADOPTED IN SMALL DAIRIES IN THE DISTRICT OF COLOMBO

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**Abstract:** In this programme on the control of mastitis, dairy farmers were advised on correct milking procedure and good hygiene at milking time. All milking cows were individually tested by means of the California Mastitis Test (CMT) and the animals were arranged in the correct milking order. All the sub-clinical and clinical cases of mastitis were treated during the first two rounds of testing. All clinical cases were treated throughout the programme. A teat dip was used. All milking cows going dry, were infused with a Dry Cow antibiotic infusion. The status of mastitis in ten small dairies supplying milk to National Milk Board, Narahenpita selected at random, was 30.7% cows positive and 14.1% quarters positive. The control programme was carried out for a period of one and half years period reducing the status to 13.1% cows positive and 5.2% quarters positive. By the end of the programme, the status of mastitis was reduced by 57.3% in cows and 63.1% in quarters from the original status at the beginning of the programme. The cost of the programme for a Farm Unit for a year was reasonable and the estimated benefit was over double the cost of the programme, for a year. Therefore the programme is recommended.

## 1. Introduction

In a previous study,[8] to assess the animal husbandry status of the dairies and the attitude of dairy farmers towards modern farming methods, it was seen that a majority of dairy farmers in Colombo and Gampaha districts do not adopt modern methods in dairy farming.

A preliminary survey on incidence of mastitis in Sri Lanka revealed an estimated loss of Rs. 4.3 million occurring annually due to this condition.[7] The estimates were based mainly on data from large Government Farms, although a large percentage of milk (about 80%) in this country is produced in small farms.

The purpose of this study was to ascertain the mastitis status among cattle and buffaloes in small holdings and to evaluate the efficacy of a simple programme for control.

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## 2. Materials And Methods

The list of milk suppliers to the National Milk Board in the district of Colombo was obtained from its Head Office at Narahenpita, in June 1977. Out of a total of 200 dairies on the list, ten were selected at random for the study. These ten dairies had a total of 101 milking cows and she buffaloes and the herd size in each ranging from 9–15 milking cows.

All quarters of cows lactating at the time of conducting the study, were tested by the California Mastitis Test (CMT) twice within a period of three weeks. The quarters that were clinically affected and those that gave positive reaction to both tests were considered positive (i.e. one round of testing). There were five rounds of testing at two to three months intervals. Effects of the programme were evaluated after the conclusion of the fifth round of testing.

At the time of the second visit in the first and the second rounds of testing, all sub-clinically affected and all clinical cases at all times during the programme were treated with one of the following antibiotic intramammary infusions, Streptopen Milking Cow (Glaxo) containing penicillin and streptomycin, Orbenin L.A. (Beecham International) containing Cloxacillin and Terramycin (Pfizer) containing Oxytetracycline HCl, at random. A sample of milk was collected aseptically before the infusion and sent to the Veterinary Research Institute (V.R.I.), Gannoruwa for bacteriological tests, namely, for isolation of organisms and antibiotic sensitivity tests.

In addition, on the first visit, the farmers were requested to adopt the following mastitis control programme: (a) washing and cleaning of milkers' hands with soap and water before milking, (b) washing and cleaning of the udders with soap and water before milking, (c) quick and complete milking of cows, (d) alternate milking of right and left side of the quarters (after the observations made at first round of testing), (e) Dipping of teats immediately after milking in a disinfectant (0.5% Hibitane –ICI with 5% glycerine as emolient), (f) treatment of sub-clinical cases at first and second rounds of testing and treatment of all clinical cases at all times, (g) milking order design on basis of C.M.T. , i.e.(i) heifers in first lactation, (ii) healthy cows without history of mastitis, (iii) cows recovered from mastitis, (iv) sub-clinical cases of mastitis under treatment, and (v) clinical cases of mastitis under treatment, (h) use of clean water in the dairy, and (i) use of Dry Cow antibiotic infusions on all cows going dry.

The dairies were closely supervised to ensure that the farmers adopt the recommended programme. Four farmers who did not cooperate were dropped out of the programme.

All cows going dry were infused with either Streptopen Dry Cow (Glaxo) containing penicillin and streptomycin or Orbenin Dry Cow

Table 1. Prevalence Of Sub-clinical And Clinical Mastitis.

| Farm No. | 1st testing | | | | 2nd testing | | | | 3rd testing | | | | 4th testing | | | | 5th testing | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cows | | Teats | | Cows | | Teats | | Cows | | Teats | | Cows | | Teats | | Cows | | Teats | |
| | +/No | % | +/No | % | +/No | % | +/No | % | +/No | % | +/No | % | +/No | % | +/No | % | +/No. | % | +/No | % |
| 1 | 0/12 | | 0/48 | – | 3/13 | 23.1 | 6/52 | 11.5 | | | | | | | | | | | | |
| 2 | 5/12 | 41.7 | 5/48 | 10.4 | 5/13 | 38.5 | 5/52 | 9.6 | 1/9 | 11.1 | 3/36 | 8.3 | 0/11 | – | 0/44 | – | 0/14 | – | 0/56 | – |
| 3 | 4/9 | 44.4 | 5/36 | 13.9 | 2/7 | 28.6 | 4/28 | 14.3 | 0/6 | – | 0/24 | – | 0/6 | – | 0/24 | – | 1/7 | 14.3 | 3/28 | 10.7 |
| 4 | 1/12 | 8.3 | 2/28 | 4.2 | 4/18 | 22.2 | 9/72 | 12.5 | 3/11 | 27.3 | 7/44 | 15.9 | 1/9 | 11.1 | 4/36 | 11.1 | 1/6 | 16.7 | 1/24 | 4.2 |
| 5 | 4/9 | 44.4 | 7/36 | 19.4 | 1/6 | 16.7 | 1/24 | 4.2 | 1/7 | 14.3 | 1/26 | 3.9 | 0/5 | – | 0/20 | – | 0/7 | - | 0/27 | – |
| 6 | 2/6 | 33.3 | 4/24 | 16.7 | 2/6 | 33.4 | 2/24 | 8.3 | 1/3 | 33.3 | 1/11 | 9.1 | 1/3 | 33.3 | 1/11 | 9.1 | 3/5 | 60.0 | 5/19 | 26.3 |
| 7 | 2/7 | 28.6 | 6/28 | 21.4 | | | | | | | | | | | | | | | | |
| 8 | 6/13 | 46.2 | 12/52 | 23.1 | 4/10 | 40.0 | 7/10 | 17.5 | 2/12 | 16.3 | 4/48 | 16.7 | 3/10 | 30.0 | 3/40 | 7.5 | | | | |
| 9 | 7/15 | 46.7 | 16/60 | 26.7 | 2/8 | 25.0 | 2/32 | 6.3 | 2/7 | 28.6 | 2/28 | 7.2 | | | | | | | | |
| 10 | 0/6 | | 0/24 | – | 1/5 | 20.0 | 1/19 | 5.3 | 0/5 | – | 0/20 | – | 0/7 | – | 0/27 | – | 1/7 | 14.3 | 1/27 | 3.7 |
| | 131/101 | 30.7 | 57/404 | 14.1 | 24/86 | 14.1 | 37/313 | 11.8 | 10/60 | 16.7 | 18/237 | 7.5 | 7/51 | 13.9 | 10/202 | 4.9 | 6/46 | 13.11 | 0/181 | 5.2 |

Table 2 – Incidence Of Mastitis (Clinical & Sub-Clinical)

| Farm No. | 1st–2nd test | | | | 2nd–3rd test | | | | 3rd–4th test | | | | 4th–5th test | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cows | % | Teats | % | Cows | % | Teats | % | Cows | % | Teats | % | Cows | % | Teats | % |
| 1 | 3/13 | 23.1 | 6/52 | 11.5 | | | | | | | | | | | | |
| 2 | 1/13 | 7.7 | 5/52 | 9.6 | 1/9 | 11.1 | 3/36 | 8.3 | 1/11 | 9.2 | 2/44 | 4.5 | 0/14 | 0 | 0/56 | 0 |
| 3 | 2/17 | 28.6 | 4/28 | 14.3 | 0/6 | 0 | 0/24 | 0 | 0/6 | 0 | 0/24 | 0 | 1/7 | 14.3 | 3/28 | 10.7 |
| 4 | 1/18 | 5.6 | 2/72 | 7.8 | 1/11 | 9.1 | 2/44 | 4.5 | 1/9 | 11.1 | 2/36 | 5.5 | 1/6 | 16.7 | 1/24 | 4.2 |
| 5 | 0/6 | 0 | 0/24 | 0 | 1/7 | 14.3 | 1/26 | 3.8 | 0/5 | 0 | 0/20 | 0 | 0/7 | 0 | 0/27 | 0 |
| 6 | 0/6 | 0 | 1/24 | 4.2 | 0/3 | 0 | 0/11 | 0 | 0/3 | 0 | 0/11 | 0 | 2/5 | 40 | 2/19 | 10.5 |
| 7 | | | | | | | | | | | | | | | | |
| 8 | 3/10 | 30 | 4/40 | 10 | 2/12 | 16.7 | 3/48 | 6.3 | 1/10 | 10 | 1/40 | 2.5 | | | | |
| 9 | 1/8 | 12.5 | 1/32 | 3.1 | 2/7 | 28.6 | 2/28 | 7.1 | | | | | | | | |
| 10 | 1/5 | 20 | 1/19 | 5.3 | 1/5 | 20 | 3/20 | 15.0 | 1/7 | 14.3 | 1/27 | 3.7 | 0/7 | 0 | 2/27 | 0 |
| Overall Incidence | 12/86 | 13.9 | 24/343 | 7.0 | 8/60 | 13.3 | 14/237 | 5.9 | 4/51 | 7.8 | 6/202 | 2.9 | 4/46 | 8.7 | 6/181 | 3.3 |

Table 3 — Incidence Of Clinical Mastitis

| Farm No. | 1st – 2nd test | | | | 2nd – 3rd test | | | | 3rd – 4th test | | | | 4th – 5th test | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cows | % | Teats | % | Cows | % | Teats | % | Cows | % | Teats | % | Cows | % | Teats | % |
| 1 | 1/12 | 8.3 | 1/48 | 2.1 | 1/10 | 10 | 2/40 | 5 | | | | | | | | |
| 2 | 1/12 | 8.3 | 3/48 | 6.3 | 2/13 | 15.4 | 2/42 | 3.9 | 2/9 | 22.2 | 4/36 | 11.1 | 0/11 | – | 0/44 | – |
| 3 | 0/9 | – | 0/36 | – | 0/7 | – | 0/28 | – | 0/6 | – | 0/24 | – | 0/6 | – | 0/24 | – |
| 4 | 0/10 | – | 0/40 | – | 0/18 | – | 0/72 | – | 0/11 | – | 0/44 | – | 1/9 | 11.1 | 2/36 | 5.6 |
| 5 | 0/9 | – | 0/36 | – | 1/6 | 16.7 | 1/22 | 4.5 | 0/7 | – | 0/26 | – | 0/5 | – | 0/20 | – |
| 6 | 0/6 | – | 0/26 | – | 1/6 | 16.7 | 1/24 | 4.2 | 1/6 | 16.7 | 2/24 | 8.3 | 0/3 | – | 0/11 | – |
| 7 | 0/13 | – | 0/28 | – | | | | | | | | | | | | |
| 8 | 1/13 | 7.7 | 1/52 | 1.9 | 0/10 | – | 0/40 | – | 0/12 | – | 0/48 | – | 0/10 | – | 0/40 | – |
| 9 | 1/15 | 6.7 | 1/60 | 1.7 | 0/8 | – | 0/32 | – | 0/7 | – | 0/28 | – | | | | |
| 10 | 0/6 | – | 0/24 | – | 1/5 | 20 | 3/19 | 15.8 | 1/5 | 20 | 1/19 | 5.3 | 0/7 | – | 0/27 | – |
| | 4/92 | 4.4 | 6/368 | 1.6 | 6/83 | 7.2 | 9/329 | 2.7 | 4/63 | 6.4 | 7/249 | 2.8 | 1/51 | 1.9 | 2/202 | 0.9 |

Table 4. – Percentage Reduction Of Prevalence of Mastitis*

| At 2nd testing | | At 3rd testing | | At 4th testing | | At 5th testing | |
|---|---|---|---|---|---|---|---|
| Cows | Teats | Cows | Teats | Cows | Teats | Cows | Teats |
| 9.1 | 16.3 | 45.6 | 46.8 | 54.7 | 65.2 | 57.3 | 63.1 |

* Reduction from its original status at first testing.

(Beecham International) containing benzathine cloxacillin, at random. The mastitis status of each quarter before infusion was known.

Sixty samples of milk collected aseptically, at random, from clinical cases and sub-clinical cases were sent to the V.R.I. for bacteriological examinations and antibiotic sensitivity test (ABS).

### 3. Results

At the beginning of the programme there were ten dairies with a total of 101 milking cows and she buffaloes. Due to lack of cooperation from farmers, the programme was carried out to an end (upto fifth round of testing) only in six dairies, with 46 milking cows in all.

The overall prevalence of mastitis (sub-clinical and clinical) at the beginning of the programme was 30.7% cows and 14.1% quarters positive (Table 1). The prevalence was reduced to 13.1% cows and 5.2% quarters positive at the fifth and the final round of testing. The incidence of mastitis (sub-clinical and clinical) was calculated between the periods between 1st–2nd, 2nd–3rd, 3rd–4th, 4th to 5th rounds of testing as shown in Table 2. It was observed that overall incidence of mastitis was reduced from 13.9% cows and 7.0% quarters positive from 1st–2nd round, to 8.7% cows and 3.3% quarters positive at 4th–5th round. Likewise, incidence of clinical mastitis at the beginning of the programme was 4.4% cows and 1.6% quarters positive (see Table 3) and was reduced to 1.9% cows and 0.9% quarters positive at the end of the proramme. Table 4 shows overall percentage reduction of prevalence from one round of testing to another as compared to status at the beginning of the programme.

It was found that at the first round of testing, the prevalence of mastitis was higher in the left side quarters (left front 21.3% and left rear 14.1%) than the right side (right front 12.8% and right rear 12.8%). Also prevalence of two front quarters were higher than the two rear quarters (front quarters 34.1% and rear quarters 19.4%).

Of the sixty samples of milk examined at V.R.I., the organisms isolated from samples in the descending order were streptococci spp., staphylococci spp., Gram negative rods and Gram positive rods (see Table 5). No isolations were made from seven samples.

Table 5. Organisms Isolated

| | No. of Isolations | % of Isolations |
|---|---|---|
| Streptococci spp. | 19 | 35.9% |
| Staphylococci spp. | 16 | 30.2% |
| Gram – ve rods | 15 | 28.3% |
| Gram + ve rods | 3 | 5.7% |
| | 53 | 100.0 |

It was seen that most isolates streptococci spp. were sensitive to penicillin and streptomycin (see Table 6) while most isolates of staphylococci spp. were sensitive to penicillin, streptomycin and chloramphenicol.

**Table 6.** – Antibiotic Sensitivity Test

| Isolate. | Total No. of isolate. | Penicillin. | Streptomycin. | Chloramphenicol. | Oxytetracycline. |
|---|---|---|---|---|---|
| Streptococci spp. | 18 | 15(83.3%) | 16(88.9%) | 12(66.7%) | 7(38.9%) |
| Staphylococci spp. | 16 | 13(81.3%) | 15(93.8%) | 13(81.3%) | 9(56.3%) |
| Gram –ve rods | 14 | 6(42.9%) | 10(71.4%) | 12(85.7%) | 6(42.9%) |
| Gram +ve rods | 3 | 1(33.3%) | 3(100%) | 3(100%) | 3(100%) |

Results of antibiotic therapy on clinical and sub-clinical cases of mastitis using penicillin and streptomycin intramammary infusion (Streptopen-Glaxo), cloxacillin intramammary infusion (Orbenin –Beecham International) and oxytetracycline HCl infusion (Terramycin-Pfizer) are shown in Table 7.

**Table 7.** – Antibiotic Therapy (Clinical and sub-clinical cases)

| Antibiotic. | No. of Quarters Treated. | No. of Quarters which Recovered | % Reduction of Mastitis |
|---|---|---|---|
| Penicillin-Streptomycin | 24 | 17 | 70.8 |
| Cloxacillin | 26 | 16 | 61.5 |
| Oxytetracycline | 20 | 11 | 55.0 |

All animals that were treated with an antibiotic infusion were tested with CMT after 3–4 weeks of infusion and quarters that were negative for both tests were regarded as recovered.

The effects of the use of Dry Cow infusion is shown in Table 8.

**Table 8.** – Antibiotic Therapy (Dry Cow Treatment)

| Antibiotic | No. of Quarters infused. | No. of Quarters positive at drying off. | No. of cases of mastitis eliminated. | No. of new cases of mastitis. | % reduction of mastitis during dry period. |
|---|---|---|---|---|---|
| Cloxacillin | 95 | 15 | 14(93.3%) | 1 | 86.7 |
| Penicillin – Streptomycin | 80 | 13 | 13(92.3%) | 1 | 84.6 |

All cows infused with dry cow infusions were tested with CMT three weeks after calving and again in two to three weeks time. Quarters that were negative for both tests were regarded as those which had been cured.

## 4. Discussion

The presence or absence of organisms in the milk sample conveys little information regarding the status of mastitis in an udder. It has been observed 70% and 80% quarters at any time were shedding pathogenic staphylococci, though there were very little mastitis in the herds concerned[5] and the milk production appeared to be normal. Somatic cell levels were comparable with the normal levels which had been previously reported.

An exudation and emigration of cells are the first sign of inflamatory reaction in the udder and the California Mastitis Test (CMT) which gives an indication of cell count, is a satisfactory diagnostic tool in a control programme.

It has been observed by some workers that the incidence of mastitis was higher in rear quarters. In Sri Lanka, Rupasinghe and Kulasegaram[6] observed that the incidence of mastitis was higher in the anterior quarters, but no explanation was given. In the present study, higher incidence of mastitis was recorded on the left side than on the right side of the udder. All these cows were hand milked. The reason is probably incorrect milking method. Almost all these milkers sit on the left side of the cow and drag down the thumb and the forefinger along the teat squeezing milk out instead of bending down the four fingers in a rhythmical manner against the thumb. These milkers first milk the left side quarters first to finish and start milking the right side quarters without giving rest to the fingers. So that the trauma on the udder due to incorrect milking procedure is higher on the left side than on the right side. This is probably a major factor causing mastitis on the area.

Streptococcal spp. were the most predominant type of infection causing mastitis in different countries. But lately, with the intensive use of penicillin in the treatment of mastitis, use of milking machines, and use of teat-dips has changed the picture from streptococcal infections to staphyloccal infections. But in this country, in the area under study, the picture still remains the same as streptococcal infections were the predominant type. In this area farmers do not misuse antibiotics to the level to that which happens in certain countries and also a considerable number of dairy farmers resort to indigenous treatment.[8] These farmers do not use milking machine and disinfection teat-dips.

In the antibiotic sensitivity test (ABS), it was found that most isolates of streptococci spp. are sensitive to penicillin and streptomycin. Most isolates of staphylococci spp. are sensitive to penicillin, streptomycin and chloramphenicol (Table 6). According to Linton,[4] sensitivity shown on artificial media *(in vitro)* depends on factors such as concentration of antibiotics on discs, rate of diffusion of a drug in medium, Gram negative and positive organisms (same drug required to produce standard zone with

Gram negative organisms is usually much greater than is required to produce a comparable reaction with Gram positive organisms), size of antibiotic molecule (chloramphenicol has a smaller molecular size and produce a greater zone of inhibition, giving false impression of sensitivity). As such, action of antibiotics such as penicillin, streptomycin, cloxacillin and oxytetracycline were estimated by infusing into the affected quarters. During this programme treatment of sub-clinical cases were tried during the first two rounds with success. This is because the average cow in this area is not a high yielding cow[8] and as such there is no dilution of antibiotic to an extent that would happen in a high yielding cow.

Intramammary infusions containing combinations of penicillin and streptomycin were the best in treatment of mastitis in the area. This is expected as mentioned earlier, dairy farmers in the area do not use antibiotics intensively.

The use of Dry Cow infusions showed that cloxacillin (Orbenin Dry Cow-Beecham International) reduced 86.7% of mastitis during dry period and penicillin and streptomycin combination (Streptopen Dry Cow-Glaxo) by 84.6% which is very satisfactory. Though farmers may believe that it is expensive to use dry cow infusions, it is evident on cost-benefit analysis, that its use is justified in spite of its cost (see below).

The primary aim of the programme was to reduce the incidence of mastitis. The different level of reduction of incidence (see Table 2) in different farms were due to differences in management practices, interest of farmers in listening to advice on control measures, beliefs of farmers, economic conditions, closing down of farms, etc. Some farmers attend to animals personally but some live elsewhere giving the responsibility of looking after the animals to others. With all types of differences, the overall incidence of mastitis was reduced satisfactorily, from 13.9% cows and 7.0% quarters positive to 8.7% cows and 3.3% quarters at the end of the programme. This is a reduction in incidence of mastitis from its original level (1st – 2nd test) by 39.2% cows and 52.9% quarters. The prevalence was reduced from 30.7% cows and 14.1% quarters positive to 13.1% cows and 5.2% quarters positive. This is a reduction from its original level (at first testing) by 57.3% in cows and 63.1% in quarters.

**Cost-Benefit Analysis**

Cost of the Programme to farmer :–

An average farm in the area has 9 cows and the average milk yield per day is 3.5 litres.[8] Price of intramammary infusion as Rs. 17/- per tube.

| | | |
|---|---|---|
| Cost of intramammary infusions at 1st & 2nd rounds | = | Rs. 17x9.3x3 |
| (three tubes for each affected quarter) | = | Rs. 474.30 |
| Cost of treatment of clinical cases 1st to 5th round | = | Rs. 17x2.3x3 |
| | = | Rs. 117.30 |
| Cost of Hibitane solution for one year | = | Rs. 50.00 |
| Cost of dry cow infusions (for 9 cows) | = | Rs. 17x4x9 |
| | = | Rs. 612.00 |
| Total cost to farmer | = | Rs. 1203.60 |

Benefit:-

Assuming that the loss of milk due to sub-clinical mastitis as 20% of the total production,

Loss per farm Unit = 9 x 3.5 x 20% = 6.3 litres.

Taking average price of milk as Rs. 3/- a litre and assuming that average lactation period is 200 days.

The loss for one year from 9 cow unit = 6.3 x 200 x 3 = Rs. 3780.00
At incidence of 1.6% clinical mastitis no. of quarters affected in a farm Unit = 9 x 4 x 1.6% = 0.6 quarters.
Loss due to 0.6 quarters per year = Rs. 3 x 0.5 lit. x 200 days
= Rs. 315.00
Total loss per year from one farm Unit = Rs. 3780 + Rs. 315
= Rs. 4095.00
Net profit per year = Rs. 4095 – Rs. 1203.60 = Rs. 2891.40
Total income from an average cow = Rs. 3x3.5x200 = Rs. 2100.00

Therefore the profit a farmer gets from the recommended mastitis control programme is roughly the profit of maintaining two more cows.

If the mastitis situation was not arrested, the intensity of the disease would have progressed throughout subsequent lactations and would have resulted in a total loss or further loss in milk production.

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# EFFECT OF TEA BREW ON THE URINARY EXCRETION AND TISSUE – DISTRIBUTION OF $^{14}C$–CAFFEINE IN THE RAT

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**Abstract :** The effect of tea brew on the excretion and tissue distribution of (1–methyl–$^{14}C$) caffeine was investigated. Following oral administration of (1–methyl–$^{14}C$) caffeine to male and female rats, the radioactivity was excreted (approx. 62% and 70% respectively) mainly in the urine, the greater part of the excretion occuring during 12 – 24h period; small amounts (approx. 7% and 9% respectively) were found in the urine. In contrast, the oral administration of (1–methyl–$^{14}C$) caffeine with tea brew resulted in an enhanced (approx. 70% and 78%) urinary excretion of radioactivity. The major urinary excretion again occuring during 12 – 24h period. Major differences were apparent in the tissue-distribution studies. The radioactivity in the stomach declined faster when caffeine was administered with tea than when pure caffeine was administered. In contrast, the radioactivity profile for blood showed a higher specific activity over a longer period when caffeine was administered with tea. The overall studies indicate that tea brew, probably reduce tissue uptake of caffeine and enhances urinary excretion.

## 1. Introduction

Caffeine is a widely consumed pharmacologically active food constituent. It occurs naturally in tea, coffee and is also used as a food additive as in chocolates and cola type soft drinks. Caffeine is a central nervous system stimulant which increases cardiac output, induces diuresis and results in a variety of psycho-pharmacological effects.[11, 15]

Until recent times, caffeine was considered as a safe food additive. However, due to recently developed evidence concerning the capacity of caffeine to cause birth defects, the concern of the Food and Drug Administration of the United States (USFDA) has shifted from caffeine's potential behavioural effects to its potential teratogenicity.[12] For example, intraperitoneal administration of caffeine to pregnant mice at dose levels of 200–250 mg/kg was embryotoxic and affected palate and limb development of the fetuses.[13, 14, 18, 20] A single subcutaneous injection of mice with 200 mg/kg of caffeine produced hematoma, clubfoot and digital defects, while higher dosages (300–400 mg/kg) produced offsprings that exhibited digital and facial deformities and muscular development disorders.[25]

Similar but variable teratogenic effects have been observed in rats[21] and rabbits.[3] The Food and Drug Administration while reviewing these data[7] indicated the possibility that at sufficiently high level of exposure, well above what humans are exposed to in the diet, caffeine can cause birth defects in animals. Subsequent studies sponsored by the FDA have further confirmed the potential teratogenic properties of caffeine.[8]

The results of these studies received considerable publicity resulting in a citizens petition to the USFDA requesting that all caffeine containing beverages be labelled as harmful to health.[5] So far the investigations by USFDA have been confined to the usage of caffeine as a food additive and regulations are under consideration by USFDA according to which all caffeine containing manufactured beverages are required to be labelled as harmful to health.

In contrast, caffeine occurs naturally in both coffee and tea. In coffee, caffeine is chemically bound with chloregenic acid to form K-caffeine-chloregenic-acid complex[16] whereas in tea, caffeine is thought to be complexed with polyphenolic substances which bind very strongly with caffeine.[6, 22] This complex is insoluble in cold water at neutral or acid pH and may influence the rate of assimilation of caffeine.[24] Thus it has been claimed[1, 9, 10] that caffeine is assimilated more slowly from tea than from coffee or aqueous solutions and that this may modify the pharmacological action of caffeine in tea in such a way as to reduce or eliminate any known harmful effects. The claim has, however, been disputed[17] as a result of observations on the levels of plasma caffeine following the administration of tea or coffee to human subjects.

Thus it seems, that the scientific data presently available on the role of tea and its components on the pharmacological effects of caffeine is rather diffuse and conflicting. The need for the availability of such data is ever increasing in view of the teratogenic effects of caffeine as previously described. Furthermore these investigations may provide evidence against any possible extension to tea, of regulations applicable to synthetic beverages containing caffeine.

## 2. Materials and Methods

### 2.1 General

All chemicals used were of an analytical grade. (1–Methyl–$^{14}$C)– caffeine was obtained from New England Nuclear (Boston, Mass, USA). Samples of Broken Orange Peckoe (B.O.P.) tea were gifts from the Tea Research Institute, Talawakelle, Sri Lanka.

## 2.2 Preparation of (1–Methyl–$^{14}$C)–caffeine

(1–Methyl–$^{14}$C) caffeine (specific radioactivity 0.10 m ci/ml) was diluted with cold caffeine and recrystallised from water to constant activity. The radio-purity was further confirmed by radiochromatography. The product had a specific activity of 0.21 u ci/mg.

## 2.3 Preparation of tea brew

Tea (10 g) was placed in a flat bottom Quickfit flask (1 l). Boiling water (400 ml) was added to it and the contents were refluxed for 10 min. At the end of this period the mixture was filtered through muslin cloth into a Volumetric flask (500 ml). The tea residue was washed with warm distilled water (approx. 4 x 25 ml) and these washings were used to make upto the mark (500 ml) of tea brew. The concentration of caffeine in this prepared tea brew was 0.1062 mg/ml.

## 2.4 Experimental animals

In all experiments Sprague-Dawley rats (200 ± 15 g body wt.) maintained on a standard laboratory diet were used.

## 2.5 Dosage and Administration of Drugs

In experiments with pure caffeine, (1–methyl–$^{14}$C)–caffeine (specific activity 0.21 u ci/mg) was dissolved in distilled water (10 mg/ml). When caffeine was administered with tea, (1–methyl–$^{14}$C)–caffeine (specific activity 0.21 u ci/mg) was dissolved in the tea brew (10 mg/ml) prepared as described previously. The tea brew containing dissolved caffeine was then incubated for 30 min at 37°C before administration. The endogenous caffeine content (0.1062 mg/ml) in tea was assumed to be negligible. Different preparations were separately administered via a stomach tube while the animal was under light diethyl ether anaesthesia.

## 2.6 Radiochemical techniques

Radioactivity counting was carried out on a Beckmann LS100C liquid scintillation counter. For aqueous samples, a dioxan system was used, comprising naphthalene (60 g), 2,5–diphenyloxazole (4 g), 1,4–bis–(5–phenyl–oxazol–2–yl)–benzene (0.2 g), methanol (100 ml) and ethylene glycol (20 ml) made upto 1 litre with dioxan. Heterogenous samples (e.g. tissue homogenates) were counted for radioactivity in the dioxan system after gelling (5% w/v) with Cab–O–Sil (Packard Instrument Co., Wembly, Middx., U.K.).

### 2.7 Excretion Studies

After administration of the appropriate preparation of caffeine, the animals (6 males and 6 females for each experiment) were placed in individual metabolism cages, where urine and faeces were collected separately after 6h, 12h, 24h and 48h and were assayed for radioactivity as previously described.

### 2.8 Tissue-distribution Studies

Rats were separately administered with either pure caffeine or caffeine with tea. Animals were killed at 1h, 3h, 6h, 12h, 24h and 48h after the drug treatment. Tissues were rapidly excised, dried on filter paper and weighed. Samples of tissues (0.1 – 1.0 g) were homogenised in sucrose (0.32M, 5 – 40 ml) and aliquots of homogenates were assayed for radioactivity as described above.

## 3. Results and Discussion

### 3.1 Excretion Studies

The urinary excretion of radioactivity following the oral administration of (100 mg/kg body wt.) (1–methyl–$^{14}$C) caffeine and (1–methyl–$^{14}$C) caffeine with tea was investigated in both male (n=6) and female (n=6) rats. Urine and faeces were collected after 6h, 12h, 25h and 48 hours. The results are given in Table 1.

Following oral administration of (1–methyl–$^{14}$C) caffeine to male rats approx. 62 percent of the radioactivity appeared in the urine over the 48h experimental period, the major proportion (33 percent) appearing during 12 – 24h period. The excretion pattern in the female, though not markedly different from male animals, showed an enhanced urinary recovery (approx. 70 percent during 48h). In both sexes appreciable amounts (7 – 9 percent) were present in faeces. Although this may be interpreted as evidence for either biliary or intestinal excretion of administered radioactivity, the possibility of some contamination of faeces by the urine cannot be ruled out. The overall urinary and faecal excretion of administered radioactivity in the male was approx. 69 percent, while in the female, it was approximately 79 percent. However, the analysis of this data by student t-test showed no statistically significant sex difference in the excretion of administered radioactivity.

In contrast, when (1–methyl–$^{14}$C) caffeine was administered with tea, the total urinary recovery of radioactivity during 48h in the male and female was approx. 67 percent and 78 percent respectively, once again

Table 1 Recovery of radioactivity after the administration of $^{14}$C –labelled caffeine

Rats (n=6) were administered either (1–methyl–$^{14}$C) caffeine or (1–methyl–$^{14}$C) caffeine (100 mg/kg body wt.) with tea orally. Urine and faeces were collected over 48h and samples were assayed for radioactivity. The results are given as Mean ± SEM.

| Collection period | | Percentage Administered Radioactivity | | | |
|---|---|---|---|---|---|
| | | Caffeine | | Caffeine with tea | |
| | | Male (n=6) | Female (n=6) | Male (n=6) | Female (n=6) |
| Urine | 0 – 6h | 8.28 ± 3.77 | 12.35 ± 3.78 | 12.18 ± 6.81 | 10.04 ± 0.98 |
| | 6 – 12h | 12.18 ± 1.78 | 12.18 ± 2.18 | 13.46 ± 2.24 | 10.93 ± 0.52 |
| | 12 – 24h | 33.64 ± 4.13 | 32.10 ± 4.95 | 28.94 ± 4.16 | 34.44 ± 1.97 |
| | 24 – 48h | 8.01 ± 1.05 | 12.85 ± 2.43 | 10.73 ± 3.12 | 23.07 ± 4.85 |
| | sub total | 62.01 ± 4.63 | 69.46 ± 7.93 | 67.3 ± 2.83 | 78.43 ± 1.56 |
| Faeces | 0 – 24h | 3.265 ± 0.35 | 3.78 ± 0.52 | 3.41 ± 1.01 | 3.42 ± 1.10 |
| | 24 – 48h | 3.48 ± 0.54 | 5.79 ± 0.67 | 3.83 ± 0.28 | 3.54 ± 1.39 |
| | sub total | 6.74 ± 0.46 | 9.34 ± 0.73 | 7.25 ± 1.02 | 6.97 ± 0.30 |
| | Grand total | 68.74 ± 4.67 | 79.04 ± 8.66 | 73.44 ± 3.08 | 85.45 ± 1.56 |

the major proportion appearing during 12 – 24h period. Faeces contained approx. 7 percent. The overall recovery of administered radioactivity in the male was approx. 73 percent while in the female it was approx. 85 percent. It is also apparent that the incorporation of $^{14}C$–labelled caffeine into tea infusion, resulted in an enhancement of urinary recovery of administered radioactivity by approx. 5 and 9 percent in the male and female respectively. This latter observation may suggest that caffeine in tea is absorbed to a lesser extent by the tissues than pure aqueous solution of caffeine and this effect appears to be more pronounced in the female than in the male. This possibility is further strengthened by the fact that the urinary excretion of administered radioactivity by the female during 24 – 48h period increased from approx. 10 percent to approx. 23 percent as a result of incorporation of labelled caffeine into tea infusion.

### 3.2 Tissue-distribution studies

In an attempt to quantify, on a time-related basis, the relative distribution of radioactivity in major tissues and also to ascertain whether there was any specific accumulation of radioactivity in any given tissue, a tissue-distribution study was undertaken. The relative patterns of distribution of radioactivity following separate oral administration of (1–methyl–$^{14}C$) caffeine and (1–methyl–$^{14}C$) caffeine with tea, in blood and in the whole homogenates of stomach, liver, heart, kidney, spleen are illustrated in Figures 1, 2 and 3.

The results are expressed as percentage of administered radioactivity/g wt. of tissue. The radioactivity in the stomach declined rapidly, the rate of this decline being faster when caffeine was administered with tea. Following the administration of (1–methyl–$^{14}C$) caffeine, the radioactivity in the blood reached a peak at 3h, and then declined sharply. In contrast, administration of labelled caffeine with tea, although resulted in a peak blood level at 3h, there was no sharp decline after 3h, but the level was maintained at a higher specific radioactivity for approx. 20 hours than when caffeine alone was administered. This observation may suggest that although caffeine in tea is rapidly absorbed from gastro-intestinal tract, its removal by the tissues from the blood, is slower than when caffeine only is administered.

It is apparent from Figures 2 and 3 that small but detectable amounts of radioactivity were associated with all tissues investigated, under both conditions of caffeine administration. However, it is important to dissociate any contribution made by labelled blood perfusing the organ from that of the actual tissue content of radioactivity. Thus a prerequisite for evidence of a greater tissue accumulation must be the occurrence of a greater specific radioactivity in the organ-tissue than in the blood. Examination of Figure 2 indicate that during 6 hours after the administration of (1–methyl–$^{14}C$)

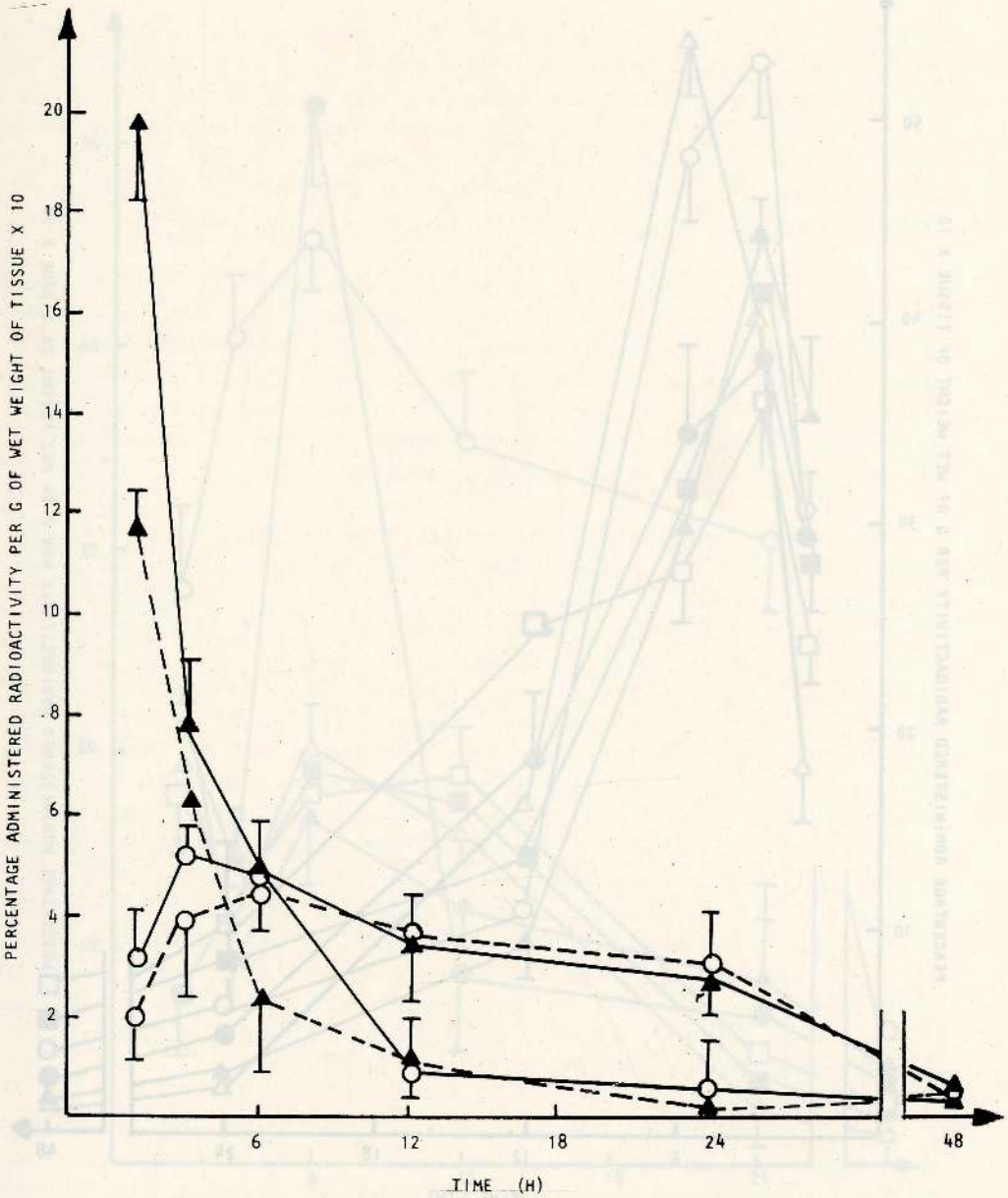


Figure 1 Tissue radioactivity after the administration of $^{14}$C–labelled caffeine

Rats (n=6) were given (1–methyl–$^{14}$C) caffeine (100 mg/kg body wt.) orally. Tissues were removed after various time intervals and assayed for radioactivity (% of administered radioactivity/g wet weight of tissue, Mean ± SEM).

○ Blood; ▲ Stomach; ——— (1–methyl–$^{14}$C) caffeine; ..... (1–methyl–$^{14}$C) caffeine with tea.

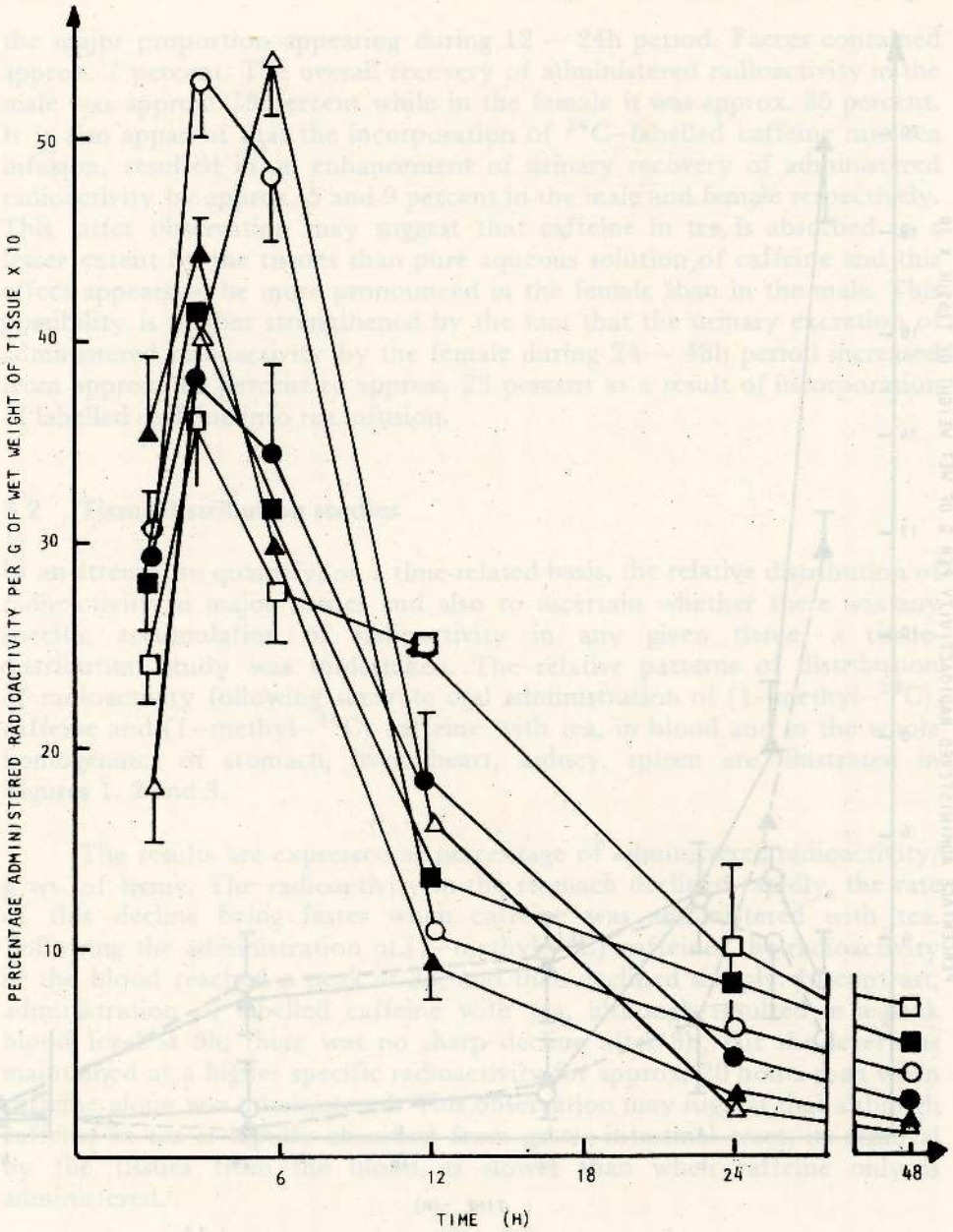


Figure 2 Tissue radioactivity after the administration of $^{14}C$–labelled caffeine

Rats (n=6) were given (1–methyl–$^{14}C$) caffeine (100 mg/kg body wt.) orally. Tissues were removed after various time intervals and assayed for radioactivity (% of administered radioactivity/g wet wt. of tissue, Mean ± SEM).

○ , Blood; △ , Heart; ● , Testes;
▲ , Kidney; ■ , Liver; □ , Spleen

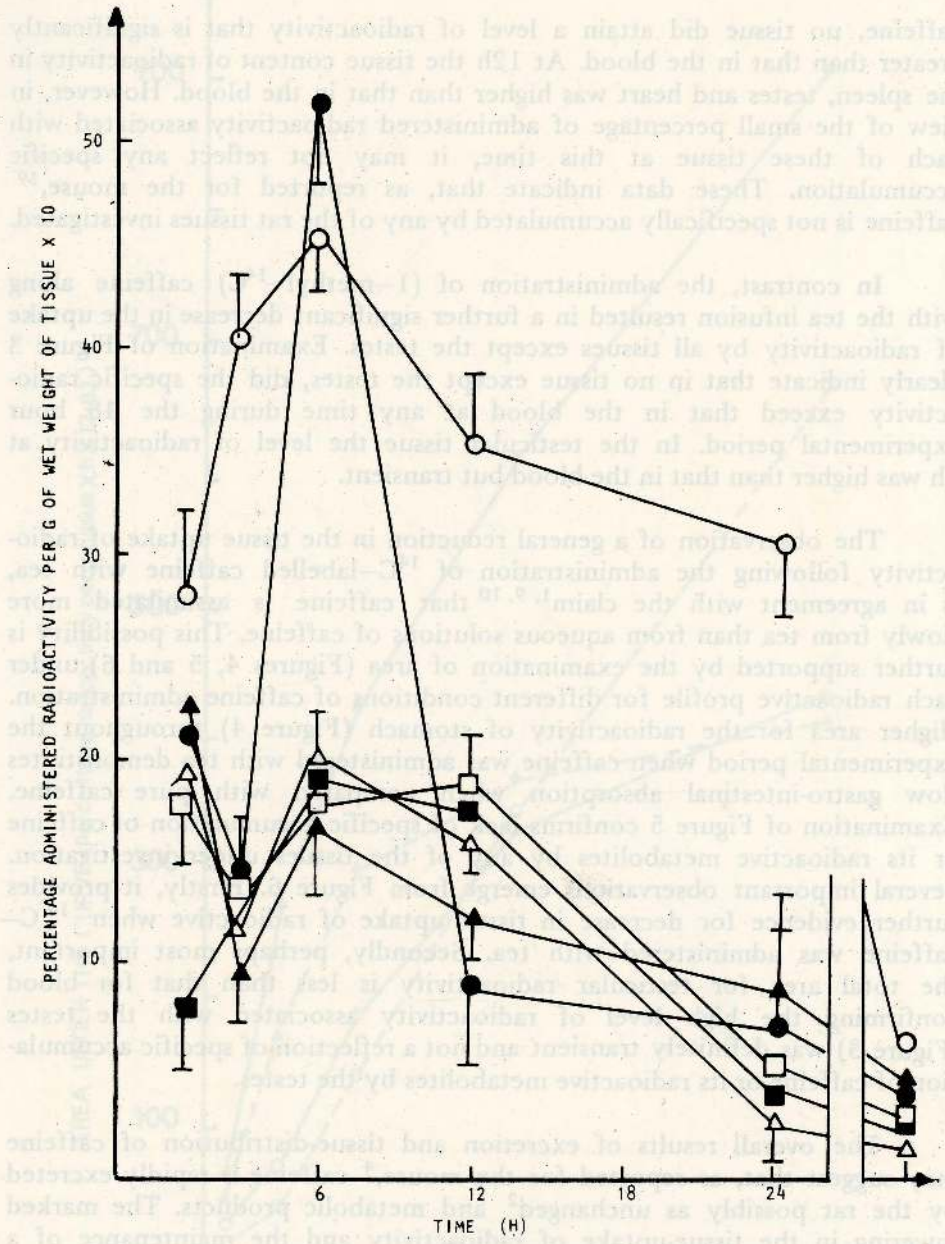


Figure 3 Tissue radioactivity after the administration of $^{14}$C–labelled caffeine with tea

Rats (n=6) were given (1–methyl–$^{14}$C) caffeine (100 mg/kg body wt) with tea. Tissues were removed after various time intervals and assayed for radioactivity (% of administered radioactivity/g wet wt of tissue, Mean ± SEM)

○ , Blood; △ , Heart; ● , Testes;
▲ , Kidney; ■ , Liver; □ , Spleen

caffeine, no tissue did attain a level of radioactivity that is significantly greater than that in the blood. At 12h the tissue content of radioactivity in the spleen, testes and heart was higher than that in the blood. However, in view of the small percentage of administered radioactivity associated with each of these tissue at this time, it may not reflect any specific accumulation. These data indicate that, as reported for the mouse,[19] caffeine is not specifically accumulated by any of the rat tissues investigated.

In contrast, the administration of (1—methyl—$^{14}$C) caffeine along with the tea infusion resulted in a further significant decrease in the uptake of radioactivity by all tissues except the testes. Examination of Figure 3 clearly indicate that in no tissue except the testes, did the specific radioactivity exceed that in the blood at any time during the 48 hour experimental period. In the testicular tissue the level of radioactivity at 6h was higher than that in the blood but transient.

The observation of a general reduction in the tissue uptake of radioactivity following the administration of $^{14}$C—labelled caffeine with tea, is in agreement with the claim[1, 9, 10] that caffeine is assimilated more slowly from tea than from aqueous solutions of caffeine. This possibility is further supported by the examination of area (Figures 4, 5 and 6) under each radioactive profile for different conditions of caffeine administration. Higher area for the radioactivity of stomach (Figure 4) throughout the experimental period when caffeine was administered with tea demonstrates slow gastro-intestinal absorption when compared with pure caffeine. Examination of Figure 5 confirms lack of specific accumulation of caffeine or its radioactive metabolites by any of the tissues under investigation. Several important observations emerge from Figure 6. Firstly, it provides further evidence for decrease in tissue uptake of radioactive when $^{14}$C—caffeine was administered with tea. Secondly, perhaps most important, the total area for testicular radioactivity is less than that for blood confirming the high level of radioactivity associated with the testes (Figure 3) was definitely transient and not a reflection of specific accumulation of caffeine or its radioactive metabolites by the testes.

The overall results of excretion and tissue-distribution of caffeine may suggest that, as reported for the mouse,[4] caffeine is rapidly excreted by the rat possibly as unchanged[2] and metabolic products. The marked lowering in the tissue-uptake of radioactivity and the maintenance of a higher specific radioactivity in the blood over a longer period following the administration of labelled caffeine with tea, while providing further support for the claim[1, 9, 10] that caffeine is assimilated more slowly from tea than from aqueous solution, it may also throw some light on the ability of tea to reduce the possible harmful effects of caffeine. It was also apparent that following the administration of labelled caffeine with tea, the clearance of radioactivity from the gastrointestinal tract was faster than when pure caffeine was administered. In contrast, the clearance of radioactivity from

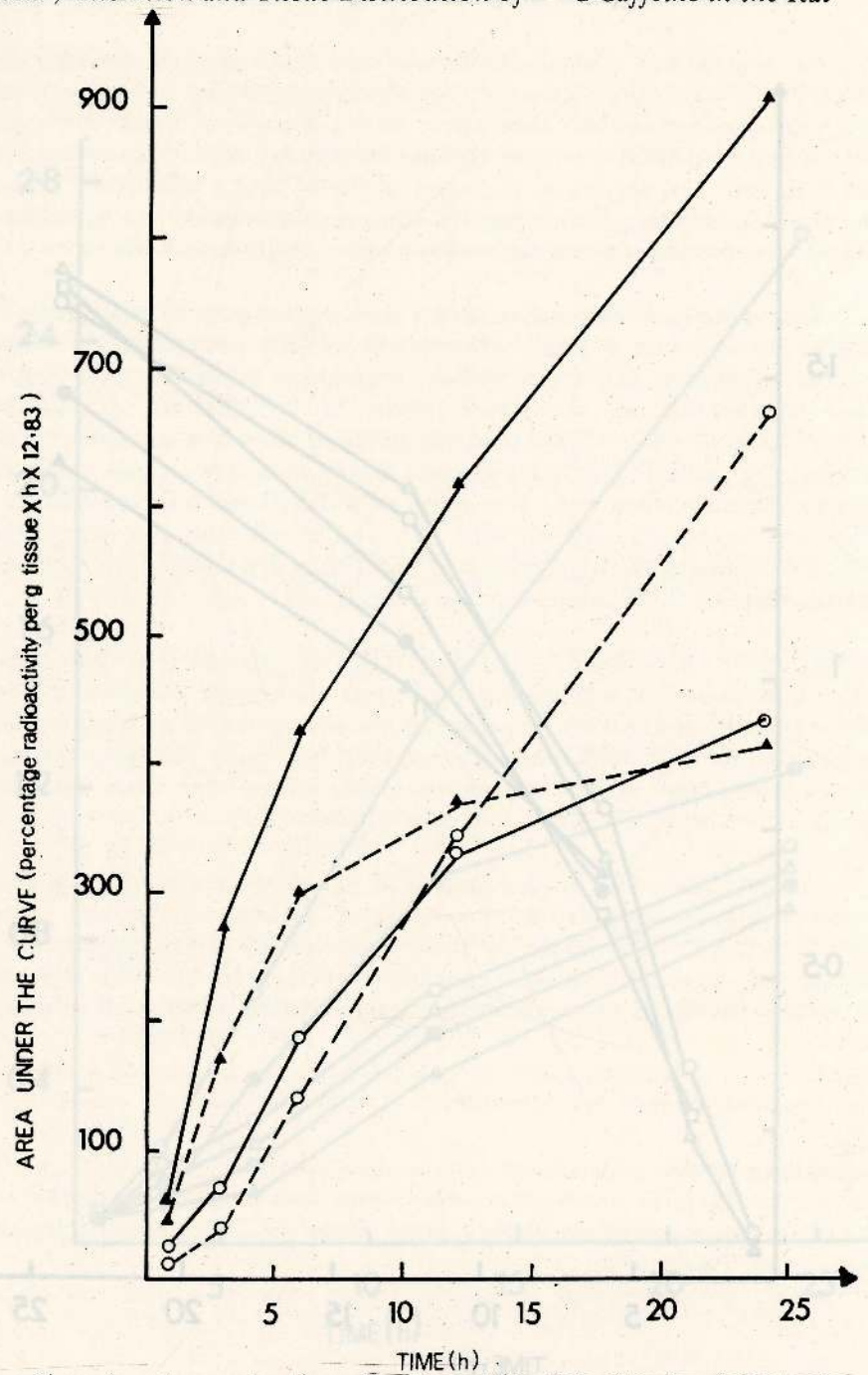


Figure 4 Area under the radioactive profiles following the administration of caffeine

, Blood; , Stomach

——— , (1—methyl—$^{14}$C) caffeine

- - - - , (1—methyl—$^{14}$C) caffeine with tea

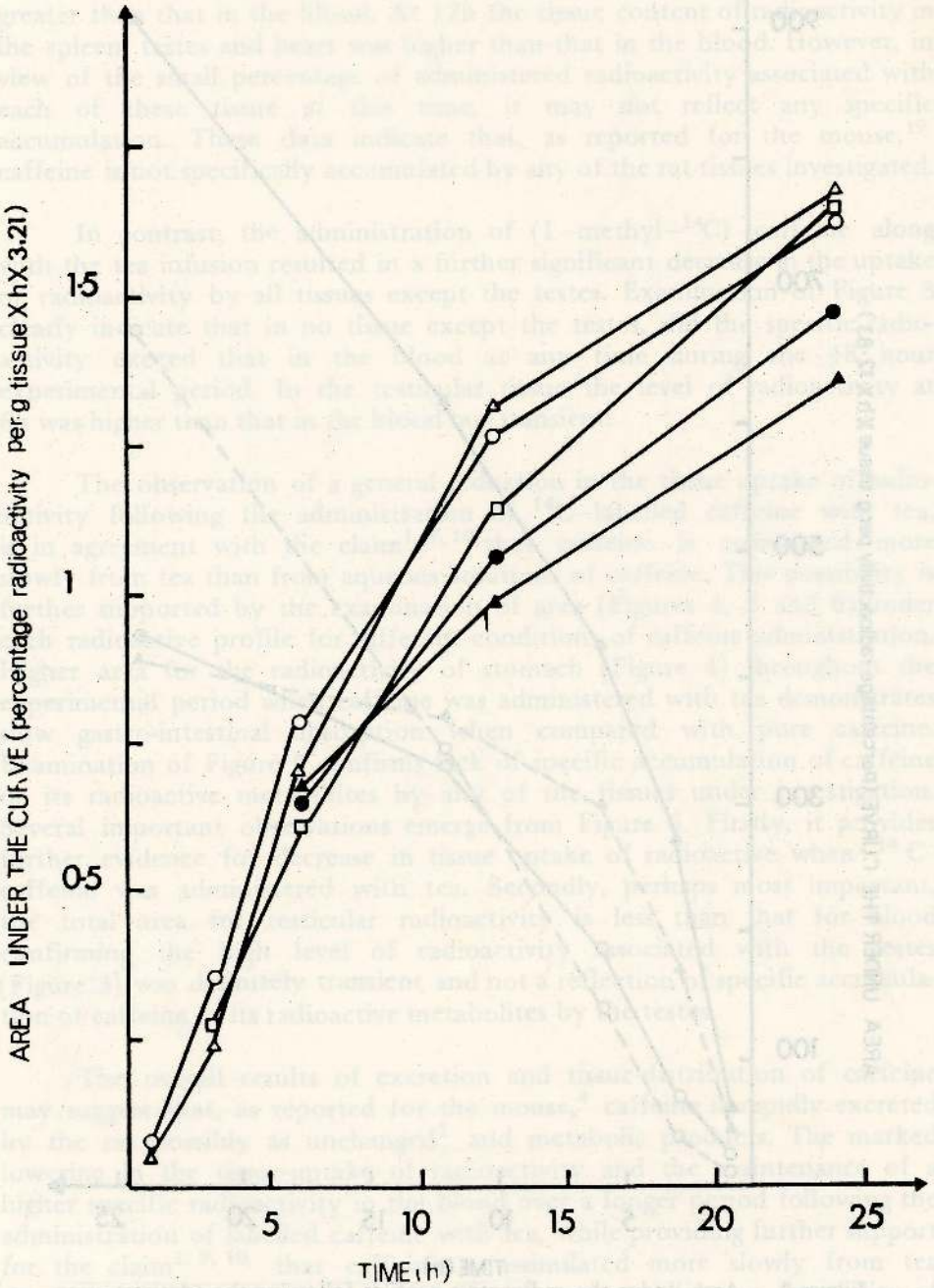


Figure 5 Area under the radioactive profiles following the administration of (1−methyl−$^{14}$C) caffeine

○ , Blood; △ , Heart; ● , Testes;
▲ , Kidney; ■ , Liver; □ , Spleen

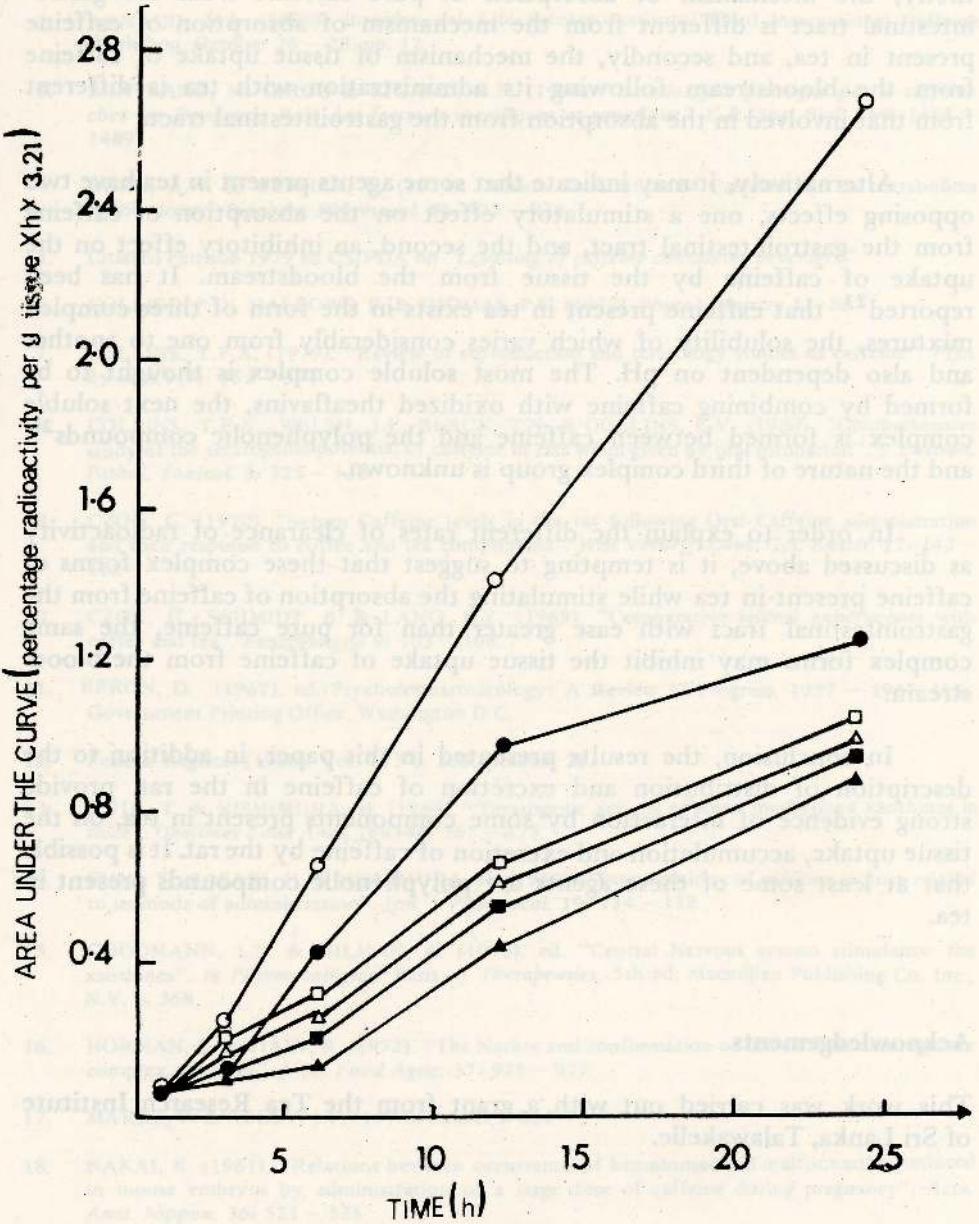


Figure 6 Area under the radioactive profiles following the administration of (1—methyl—$^{14}$C) caffeine with tea

○ , Blood; △ , Heart; ● , Testes;
▲ , Kidney ■ , Liver; □ , Spleen

the blood was slower when caffeine was administered with tea than when pure caffeine was administered. The observation seems to suggest that, firstly, the mechanism of absorption of pure caffeine from the gastrointestinal tract is different from the mechanism of absorption of caffeine present in tea, and secondly, the mechanism of tissue uptake of caffeine from the bloodstream following its administration with tea is different from that involved in the absorption from the gastrointestinal tract.

Alternatively, it may indicate that some agents present in tea have two opposing effects, one a stimulatory effect on the absorption of caffeine from the gastrointestinal tract, and the second, an inhibitory effect on the uptake of caffeine by the tissue from the bloodstream. It has been reported[23] that caffeine present in tea exists in the form of three complex mixtures, the solubility of which varies considerably from one to another and also dependent on pH. The most soluble complex is thought to be formed by combining caffeine with oxidized theaflavins, the next soluble complex is formed between caffeine and the polyphenolic compounds[26] and the nature of third complex group is unknown.

In order to explain the different rates of clearance of radioactivity as discussed above, it is tempting to suggest that these complex forms of caffeine present in tea while stimulating the absorption of caffeine from the gastrointestinal tract with ease greater than for pure caffeine, the same complex forms may inhibit the tissue uptake of caffeine from the bloodstream.

In conclusion, the results presented in this paper, in addition to the description of distribution and excretion of caffeine in the rat, provide strong evidence of interaction by some components present in tea, on the tissue uptake, accumulation and excretion of caffeine by the rat. It is possible that at least some of these agents are polyphenolic compounds present in tea.

**Acknowledgements**

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# MOISTURE ADSORPTION THROUGH PACKAGING MATERIALS USED FOR DESICCATED COCONUTS

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**Abstract:** In Sri Lanka, desiccated coconuts are dried to a moisture content below 3 percent and packed in 50 kg quantities in bags made of 85 $\mu$ thick low density polyethylene forming the inner lining of a 5 tier paper bag. These bags are exposed to varying relative humidities for several months during storage and transport permitting adsorption of moisture by desiccated coconuts. Fine grade desiccated coconuts (10 g) were sealed in 10 cm x 5 cm bags made of packaging materials low density polyethylene (85 $\mu$), double layer low density polyethylene (60 $\mu$), high density polyethylene (40 $\mu$), polypropylene (50 $\mu$), adhesive laminated aluminium foil (10 $\mu$) on low density polyethylene (75 $\mu$) and triple laminated foil made of polyester (12 $\mu$)/aluminium foil (10 $\mu$)/polyethylene (60 $\mu$). The bags were stored at relative humidities of 33%, 70%, 80%, 100% and that of the atmosphere. The gain in weight by the bags was estimated at 5 day intervals for 90 days. At 33% RH a drop in weight of the bags was observed. An increase in weight was observed at all other relative humidities. Of the materials tested the laminated materials showed better resistance to moisture movement across them. The double laminated material was the best. The desiccated coconuts stored in the laminated materials did not gain moisture to reach the critical level of 3.5% at relative humidities below 80% and at RH of the atmosphere. Even at 100% RH the desiccated coconuts stored in laminated materials reached the critical moisture level only after 83 days as against 6 days observed for other materials. It is recommended that desiccated coconuts be packed in double laminated aluminium/polythene materials.

## 1. Introduction

The shredded dried coconut kernel is used in the preparation of confectionaries in many Western countries. The coconut kernel is preserved for this purpose by drying it to a moisture level below 3 percent. The product is called desiccated coconut. In Sri Lanka, desiccated coconuts are packed into 50 kg bags for export. The bags are made of an inner low density polyethylene (LDPE) lining of 85 $\mu$ thickness and an outer 5 tier paper bag. The LDPE is heat sealed at the two ends to prevent adsorption of moisture. However, the packaging material, LDPE and the craft paper are not completely impermeable to moisture.

These bags are exposed to varying relative humidities for durations upto six months in storage and transport permitting movement of moisture across the packaging materials and adsorption or desorption by the desiccated coconuts. Moisture levels as low as 4—7 percent have been observed to support mold growth[1] and cause off odours due to growth of xerophilic fungi in desiccated coconuts.[2]

In this study six types of packaging materials used for the storage of desiccated coconuts were compared at different relative humidities with respect to their moisture adsorption/desorption patterns.

## 2. Materials and Methods

### 2.1 Packaging materials

The following packaging materials were tested :

Double layer low density polyethylene (60 $\mu$)
High density polyethylene (40 $\mu$)
Low density polyethylene (85 $\mu$)
Adhesive laminated aluminium foil (10 $\mu$) on low density polyethylene (40 $\mu$)
Polypropylene (50 $\mu$)
Triple laminated foil made of polyester (12 $\mu$), aluminium foil (9 $\mu$) and polyethylene (60 $\mu$)

### 2.2 Estimation of moisture

Desiccated coconut (5 g) was dried at 102°C for 2 hours for the estimation of moisture.[3]

### 2.3 Moisture adsorption

Desiccated coconut (10 g) containing 2.7% moisture were sealed in bags (10 cm x 5 cm) of the above packaging materials. They were exposed to different relative humidities at 25°C in desiccators equilibrated with the following saturated solutions for 2 weeks prior to introduction of the bags :

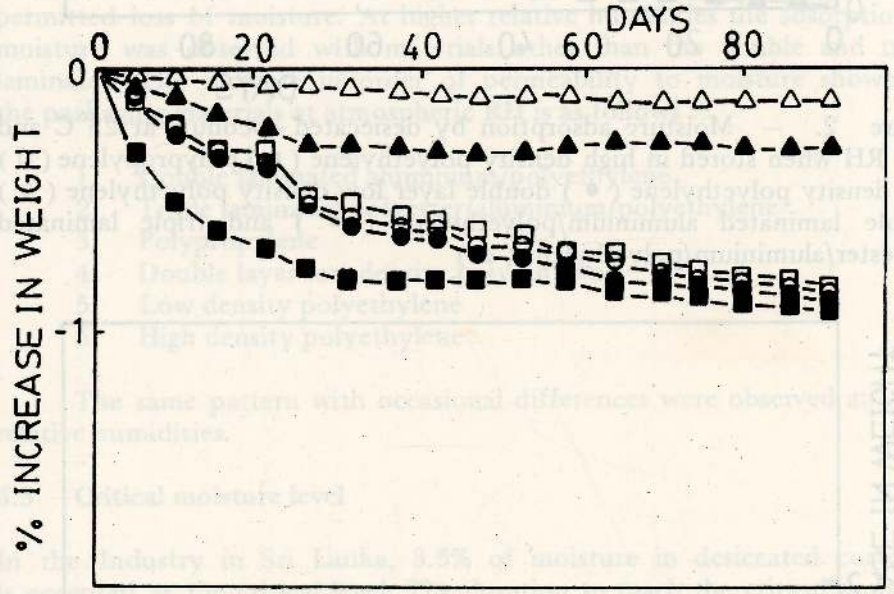
33% — magnesium chloride
70% — sodium chloride
80% — potassium chloride
100% — distilled water
Atmospheric — open desiccator with no solution (varied between 72% to 83%).

The packed samples were weighed at 5 day intervals. They were observed for visible growth of molds. The moisture content of the desiccated coconuts was determined after termination of the experiment on the 90th day. All experiments were done in duplicate.

## 3. Results and Discussion

### 3.1 Moisture adsorption pattern

The percentage increase in weight of desiccated coconuts (DC) due to adsorption of moisture at relative humidities (RH) of 33%, 70% and atmospheric are presented in Figures 1 – 3.




Legends for figures

Figure 1. – Moisture adsorption by desiccated coconuts at 25°C and 33% RH when stored in high density polyethylene ( ■ ) polypropylene ( □ ) low density polyethylene ( • ) double layer low density polyethylene ( ○ ) double laminated aluminium/polyethylene ( ▲ ) and triple laminated polyester/aluminium/polyethylene ( Δ )

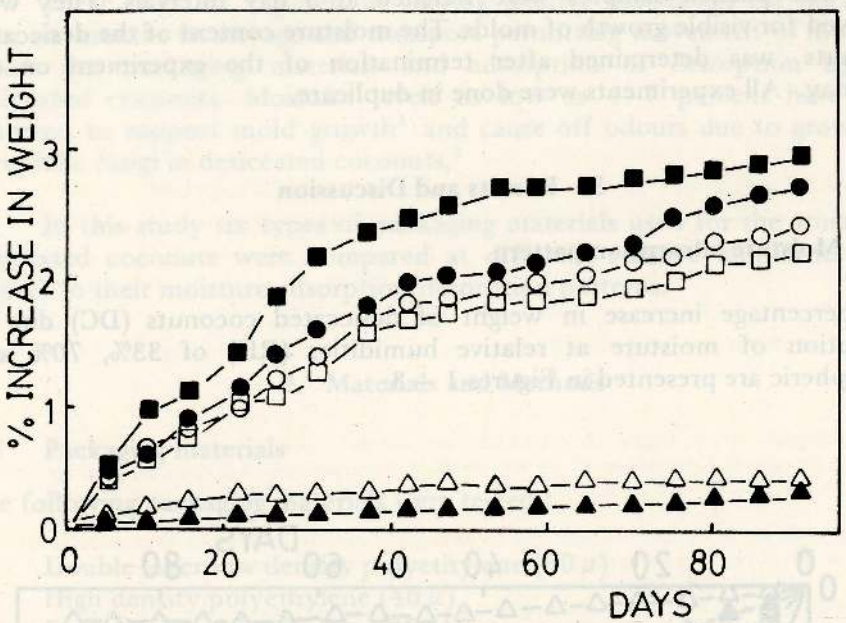



Figure 2. — Moisture adsorption by desiccated coconuts at 25°C and 70% RH when stored in high density polyethylene ( ■ ) polypropylene ( □ ) low density polyethylene ( ● ) double layer low density polyethylene ( ○ ) double laminated aluminium/polyethylene ( ▲ ) and triple laminated polyester/aluminium/polyethylene ( Δ )

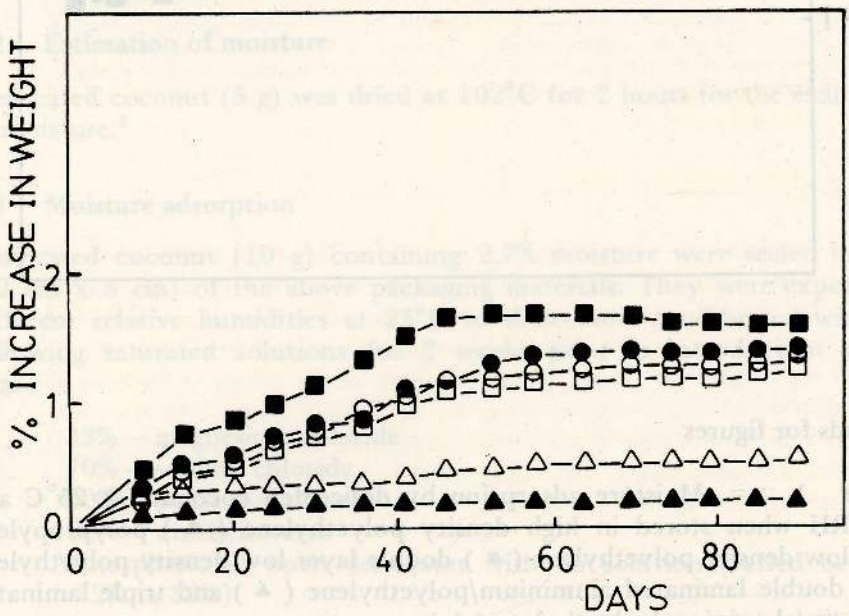



Figure 3. — Moisture adsorption by desiccated coconuts at 25°C and atmospheric relative humidity when stored in high density polyethylene ( ■ ) polypropylene ( □ ) low density polyethylene ( ● ) double layer low density polyethylene ( ○ ) double laminated aluminium/polyethylene ( ▲ ) and triple laminated polyester/aluminium/polyethylene (Δ )

At 80% and 100% RH moisture adsorption were higher than at 70%. At 33% RH loss of moisture was observed. At atmospheric RH the moisture in the DC appeared to equilibrate with that of the atmosphere in about 2 months in the six packaging materials tested.

Of the packaging materials tested the double laminated and triple laminated materials permitted minimum moisture movement across them at all relative humidities. The double laminated material appeared to be a better moisture barrier than the triple laminated material.

### 3.2 Final moisture percentage

The final moisture percentages observed in DC after 90 days of storage are presented in Table 1. At 33% RH the double and triple laminated materials showed resistance to moisture loss and the original moisture content of 2.7% in DC was more or less retained, whereas other materials permitted loss of moisture. At higher relative humidities the adsorption of moisture was observed with materials other than the double and triple laminates. The increase in order of permeability to moisture shown by the packaging materials at atmospheric RH is as follows :

1. Double laminated aluminium/polyethylene
2. Triple laminated polyester/aluminium/polyethylene
3. Polypropylene
4. Double layer low density polyethylene
5. Low density polyethylene
6. High density polyethylene

The same pattern with occasional differences were observed at other relative humidities.

### 3.3 Critical moisture level

In the Industry in Sri Lanka, 3.5% of moisture in desiccated coconuts is accepted as the critical level. The duration to reach the critical moisture level with the six packaging materials at different relative humidities are presented in Table 2. At 33% RH this situation did not arise as there was no adsorption of moisture by DC. With double and triple laminated materials the adsorption of moisture by DC to reach critical moisture level was observed only at 100% RH. This, too, was after 12 weeks of storage. Here the double laminated material appeared to be slightly better than the triple laminated material. The packaging material used today in the industry, low density polyethylene permitted adsorption of moisture beyond critical level within 30 days. This indicates the possibility of DC adsorbing sufficient moisture to permit the mold spoilage during storage at atmospheric RH.

Table 1. The final moisture percentage observed in desiccated coconuts after exposure to different relative humidities (R.H.) in different packaging materials at 25°C for 90 days

| Packaging material | Moisture % after 90 days at R.H. of | | | | |
|---|---|---|---|---|---|
| | 33% | 70% | 80% | 100% | Atmospheric |
| Double layer low density polyethylene | 1.9 | 5.2 | 6.2 | 9.2 | 4.1 |
| High density polyethylene | 1.8 | 6.2 | 9.5 | 13.8 | 4.4 |
| Low density polyethylene | 1.8 | 5.4 | 6.2 | 10.6 | 4.3 |
| Double laminated aluminium/polyethylene | 2.5 | 3.1 | 3.1 | 3.7 | 3.1 |
| Polypropylene | 1.9 | 4.8 | 6.1 | 11.2 | 4.0 |
| Triple laminated polyester/aluminium/polyethylene | 2.6 | 3.3 | 3.5 | 3.8 | 3.4 |

Table 2 The duration in days to reach the critical moisture level of 3.5% when desiccated coconut containing 2.7% moisture was stored in different packaging materials at different relative humidities (R.H.) and 25°C

| Packaging material | Number of days to react 3.5% moisture at R.H. of | | | | |
|---|---|---|---|---|---|
| | 33% | 70% | 80% | 100% | Atmospheric |
| Double layer low density polyethylene | – | 14 | 12 | 2 | 33 |
| High density polyethylene | – | 8 | 6 | 4 | 15 |
| Low density polyethylene | – | 13 | 11 | 2 | 30 |
| Double laminated aluminium/polyethylene | – | – | – | 87 | – |
| Polypropylene | – | 15 | 13 | 6 | 35 |
| Triple laminated polyester/aluminium/polyethylene | – | – | – | 83 | – |

– 3.5% was not reached

The atmospheric RH observed during the experiment varied between 72% to 83%. In contrast to this, the moisture adsorption by DC under atmospheric RH corresponded to RH of 54% to 74% when calculated on the basis of other RH conditions used in the experiment. This difference is perhaps, due to the variations in RH with time allowing both gain and loss of moisture through the packaging materials and also may be associated with movement of air in the open desiccator which prevented a continuous fixed RH around the packed DC bags at atmospheric RH in contrast to fixed RH in closed desiccators.

### 3.4 Growth of molds

Molds were visible to the naked eye in the packed desiccated coconut as the moisture concentration passed 6 percent level irrespective of the packaging materials and the relative humidity of storage.

## 4. Conclusion

The packaging material used today for DC, low density polyethylene appeared to permit the adsorption of moisture allowing DC to reach the critical moisture level of 3.5% in about a month. The double laminated aluminium/polyethylene was the best among the materials tested. The attention of the desiccated coconut industry is drawn to this.

## Acknowledgements

The authors wish to thank the Coconut Development Authority, Sri Lanka, for assistance in this study.

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# ELECTRONIC TRANSPORT IN CUPRIC FERROCYANIDE ACTIVATED BY INTERSTITIAL WATER MOLECULES

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*(Date of receipt : 22 January 1985)*
*(Date of acceptance : 17 April 1985)*

**Abstract :** Coordinated and free interstitial water molecules in cupric ferrocyanide is found to excite electronic conduction with different activation energies. Theoretical argument is given to explain the observations.

## 1. Introduction

Ferrocyanides and ferricyanides of heavy metals form crystalline solids of similar structure with interesting properties.[1, 2, 5, 6, 15] All these materials have face-centred cubic arrangement of metal cations at the corners of unit cubes linked by cyanide ions placed along the edges. In a ferrocyanide the carbon atom of $CN^-$ is coordinated to $Fe^{2+}$ and the nitrogen atom is coordinated to the other metal ion. Ferricyanides have the same type of bondings with $Fe^{2+}$ replaced by $Fe^{3+}$. A property arising from this structure is that the unit cells are unusually large (lattice constant $\sim$ 10A°) and as a result the crystal can accommodate foreign molecules, generally water as interstitial impurities.[1, 2, 4, 5, 6, 7, 15] It is known that coordinated as well as free water molecules could exist within the interstices of prussian blue type of compounds. X-ray structural analysis indicates that the coordinated water molecules are located near the metal cations and the free water molecules gets hydrogen bonded to the coordinate ones.[5] However, on thermodynamical grounds the author has argued that a small fraction of free water molecules could also get located within the ferro- or ferricyanide ions.[10] The author and co-workers[8, 9, 10, 11, 12, 13] have noted that most ferro- and ferricyanides exhibits electronic conduction in the presence of interstitial water with the following characteristics :

(1) Conductivity decreases rapidly once a critical temperature $T_c$ (110–140 C) is exceeded.

(2) The thermal activation energy of charge carriers generally have the same order of magnitude 0.25–0.35 eV (Table 1)

(3) Unless the concentration of free water molecules is largely in excess of the bound ones, the majority charge carriers in ferrocyanides are electrons and those in ferricyanides are holes (Table 1).

Table I

| Compound | E(eV) | $T_c$ | Type |
|---|---|---|---|
| $Zn_2[Fe(CN)_6].3H_2O$ | 0.32 | 110 | n |
| $Cd_2[Fe(CN)_6].xH_2O$ | 0.35 | 110 | n |
| $Pb_2[Fe(CN)_6].2.4H_2O$ | 0.32 | 110 | n |
| $Cu_2[Fe(CN)_2].2H_2O$ | 0.57 | 110 | p |
| $Ho_4[Fe(CN)_6]_3.5H_2O$ | 0.38 | 130 | n |
| $Er_4[Fe(CN)_6]_3.5H_2O$ | 0.36 | 130 | n |
| $Yb_4[Fe(CN)_6]_3.5H_2O$ | 0.39 | 130 | n |
| $Eu_4[Fe(CN)_6]_3.5H_2O$ | 0.39 | 128 | n |
| $Gd_4[Fe(CN)_6]_3.5H_2O$ | 0.39 | 142 | n |
| $Zn_3[Fe(CN)_6]_2.5H_2O$ | 0.27 | 117 | p |
| $Cd_3[Fe(CN)_6]_2.5H_2O$ | 0.27 | 120 | p |
| $Pb_3[Fe(CN)_6]_2.xH_2O$ | 0.26 | 112 | p |
| $Cu_3[Fe(CN)_6]_2.12H_2O$ | 0.23 | 118 | p |
| $Cd_3[Fe(CN)_6]_2.xH_2O$ | 0.25 | 122 | p |

(4) Ferri– and Ferrocyanides with few molecules of coordinated water (e.g. lead ferrocyanide with two molecules of coordinate water) tend to exhibit electronic conduction only if free molecules water are also present.

The author has shown that although it is thermodynamically more favourable for $H_20$ molecules to get coordinated near the metallic ions a small fraction of ferro– or ferricyanide ions could also get hydrated.[10] The hydrated ferrocyanide (ferricyanide) ions (Figure 1) donate (accept) electron to (from) the conduction (valence) band, [8, 9, 10, 11, 12, 13] i.e.,

**Figure 1**

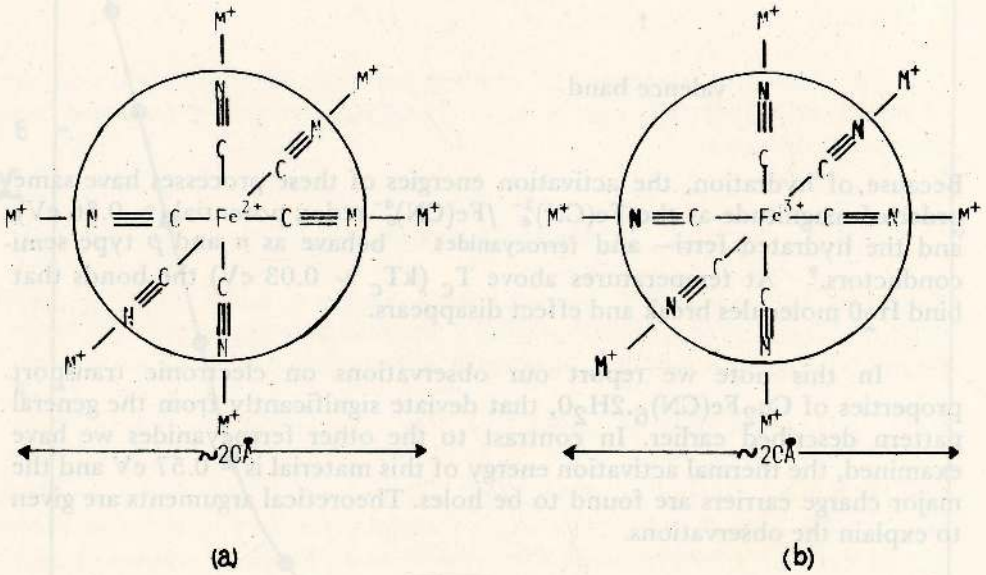


Figure 1. Diagrams showing the octahedral linkage of $CH^-$ ions into (a) $Fe^{2+}$ ion in ferrocyanide (b) $Fe^{3+}$ ion in a ferricyanide ($M^+$ is a metal ion). When the spherical region denoted by the circle is filled with $H_2O$ molecules (a) and (b) behave as ferro- and ferricyanide ions in aqueous solution.

**Ferrocyanides**

$$Fe(CN)_6^{4-} \rightarrow Fe(CN)_6^{3-} + e$$

$$\downarrow$$

conduction band

**Ferricyanides**

$$Fe(CN)_6^{3-} + e \rightarrow Fe(CN)_6^{4-}$$

$$\uparrow$$

valence band

Because of hydration, the activation energies of these processes have same order of magnitude as the $Fe(CN)_6^{3-}$ /$Fe(CN)_6^{4-}$ redox potential ($\sim$ 0.36 eV) and the hydrated ferri– and ferrocyanides behave as *n* and *p* type semiconductors.[9] At temperatures above $T_c$ ($kT_c \sim 0.03$ eV) the bonds that bind $H_20$ molecules break and effect disappears.

In this note we report our observations on electronic transport properties of $Cu_2Fe(CN)_6.2H_20$, that deviate significantly from the general pattern described earlier. In contrast to the other ferrocyanides we have examined, the thermal activation energy of this material is $\simeq$ 0.57 eV and the major charge carriers are found to be holes. Theoretical arguments are given to explain the observations.

## 2. Experimental

Measurements were made with compressed pellets as well as single crystals. The material for making compressed pellets were made by the decomposition of copper sulphate with potassium ferrocyanide in the presence of dilute nitric acid (acid prevents the contamination of the product with cupric hydroxide resulting from hydrolysis). The precipitate was washed with deionized water and dried in vacuum at 40°C. Chemical analysis confirmed that it corresponds to stoichiometric $Cu_2Fe(CN)_6 .2H_2O$. It was noted that unlike other heavy metal ferrocyanides the bound water molecules cannot be removed by prolonged drying in vacuum at temperatures below 110°C. Thermal gravimetric analysis also indicated that the hydration number of the material is 2 (Figure 2).

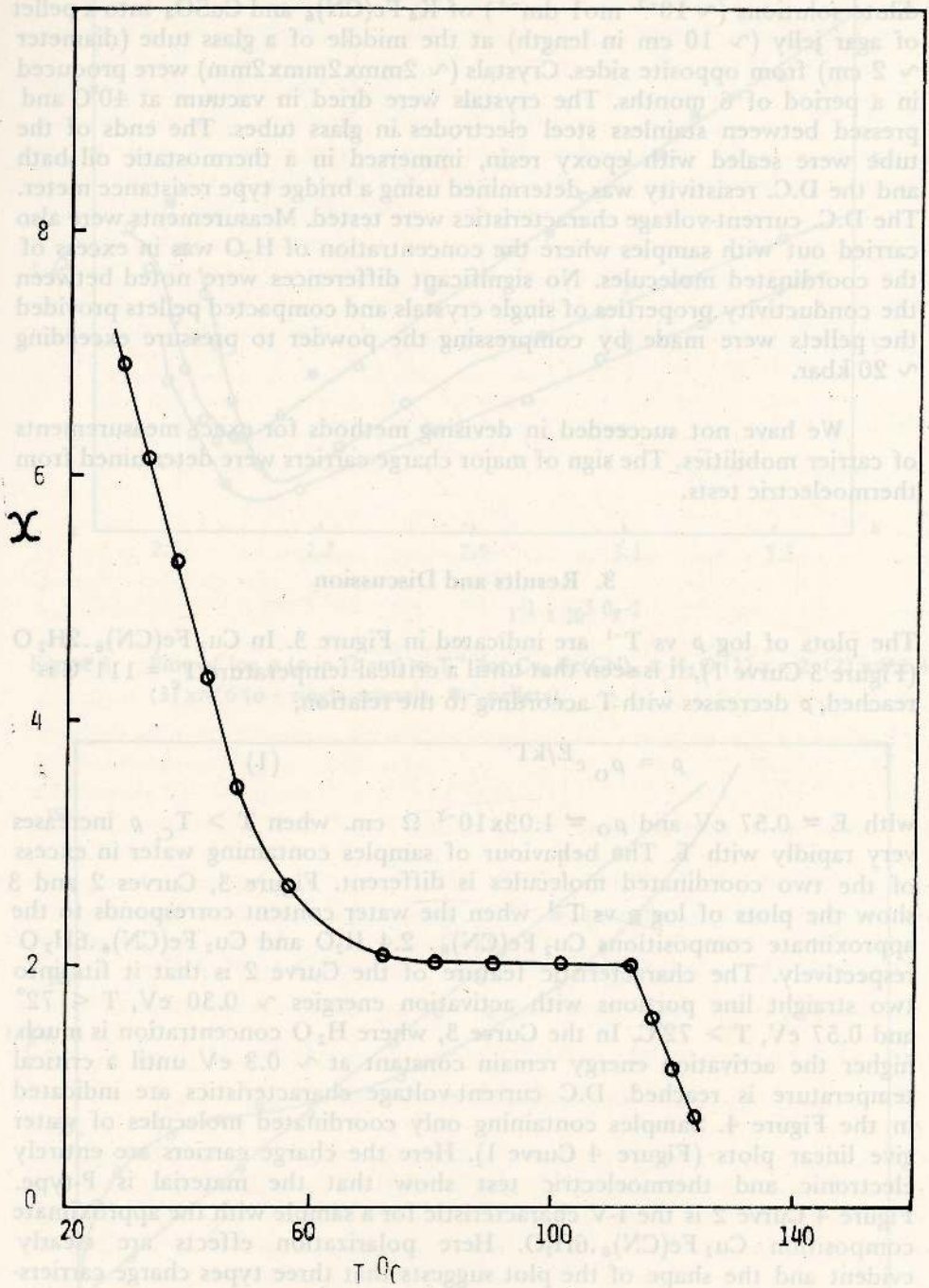


Fig. 2.

Figure 2. Thermal gravimetric analysis data for $Cu_2Fe(CN)_6.xH_2O$. Plot of x vs T when heated at a constant rate ($2^{\circ}C\ min^{-1}$).

Single crystals of cupric ferrocyanide were prepared by diffusing very dilute solutions ($\sim 10^{-3}$ mol $dm^{-3}$) of $K_4 Fe(CN)_6$ and $CuSO_4$ into a pellet of agar jelly ($\sim$ 10 cm in length) at the middle of a glass tube (diameter $\sim$ 2 cm) from opposite sides. Crystals ($\sim$ 2mmx2mmx2mm) were produced in a period of 6 months. The crystals were dried in vacuum at 40°C and pressed between stainless steel electrodes in glass tubes. The ends of the tube were sealed with epoxy resin, immersed in a thermostatic oil bath and the D.C. resistivity was determined using a bridge type resistance meter. The D.C. current-voltage characteristics were tested. Measurements were also carried out with samples where the concentration of $H_2O$ was in excess of the coordinated molecules. No significant differences were noted between the conductivity properties of single crystals and compacted pellets provided the pellets were made by compressing the powder to pressure exceeding $\sim$ 20 kbar.

We have not succeeded in devising methods for exact measurements of carrier mobilities. The sign of major charge carriers were determined from thermoelectric tests.

### 3. Results and Discussion

The plots of log $\rho$ vs $T^{-1}$ are indicated in Figure 3. In $Cu_2 Fe(CN)_6 .2H_2 O$ (Figure 3 Curve 1), it is seen that until a critical temperature $T_c$ = 111°C is reached, $\rho$ decreases with T according to the relation,

$$\rho = \rho_O e^{E/kT} \qquad (1)$$

with E $\simeq$ 0.57 eV and $\rho_O \simeq 1.03 \times 10^{-3}$ $\Omega$ cm. when $T > T_c$, $\rho$ increases very rapidly with T. The behaviour of samples containing water in excess of the two coordinated molecules is different. Figure 3, Curves 2 and 3 show the plots of log $\rho$ vs $T^{-1}$ when the water content corresponds to the approximate compositions $Cu_2 Fe(CN)_6 .$ 2.4 $H_2O$ and $Cu_2 Fe(CN)_6 .6H_2 O$ respectively. The characteristic feature of the Curve 2 is that it fits into two straight line portions with activation energies $\sim$ 0.30 eV, T $\leqslant$ 72° and 0.57 eV, T > 72°C. In the Curve 3, where $H_2 O$ concentration is much higher the activation energy remain constant at $\sim$ 0.3 eV until a critical temperature is reached. D.C current-voltage characteristics are indicated in the Figure 4. Samples containing only coordinated molecules of water give linear plots (Figure 4 Curve 1). Here the charge carriers are entirely electronic and thermoelectric test show that the material is P-type. Figure 4 Curve 2 is the I-V characteristic for a sample with the approximate composition $Cu_2 Fe(CN)_6 .6H_2O$. Here polarization effects are clearly evident and the shape of the plot suggests that three types charge carriers-electron holes and ions-are present.[3, 14] The ionic carriers are probably protons or $H_3^+O$ ions.

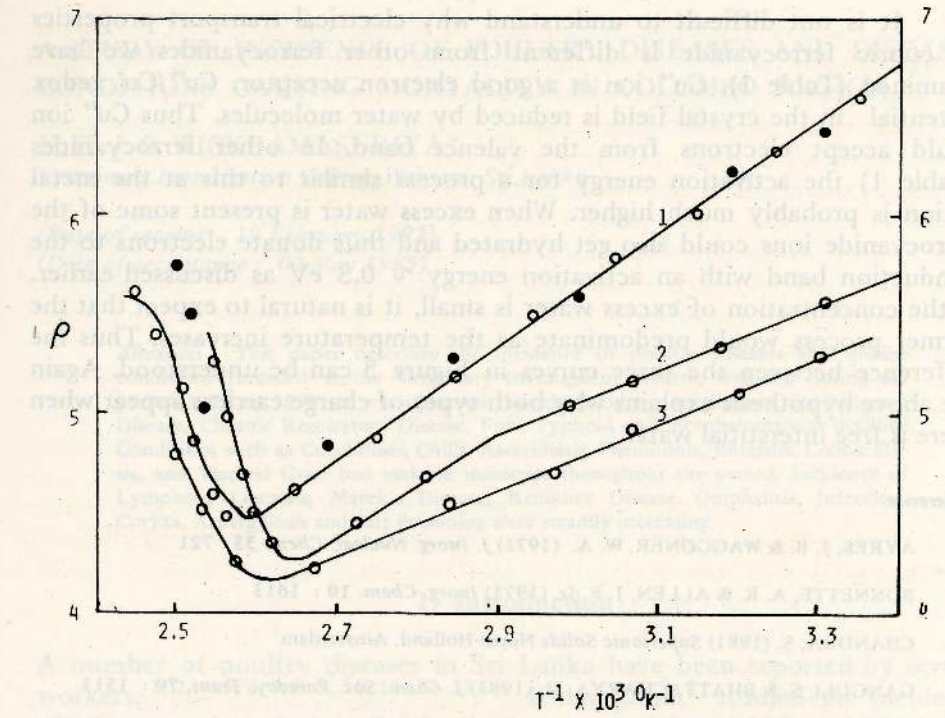


Figure 3. Plot of log $\rho$ ($\rho$ in $\Omega$ cm) vs $T^{-1}$ for $Cu_2Fe(CN)_6.x\,H_2O$ (1) x = 2 (2) x≃2.4 (3) x≃6 (o - single crystals, ● - pellets).

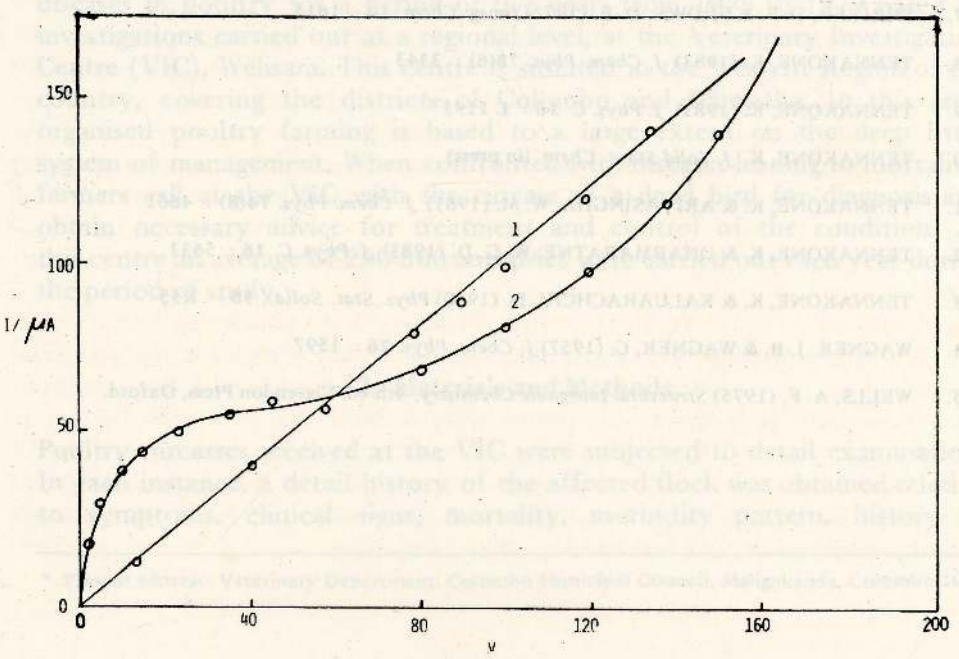


Figure 4. I - V characteristics for $Cu_2Fe(CN)_6.x\,H_2O$ (1) x = 2 (2) x≃2.4 (3) x≃6 (measurements carried out with slices of crystals ∿ 2mm x 2mm x 2mm).

It is not difficult to understand why electrical transport properties of cupric ferrocyanide is different from other ferrocyanides we have examined (Table 1). $Cu^{++}$ ion is a good electron acceptor. $Cu^{++}/Cu^{+}$ redox potential in the crystal field is reduced by water molecules. Thus $Cu^{++}$ ion could accept electrons from the valence band. In other ferrocyanides (Table 1) the activation energy for a process similar to this at the metal cation is probably much higher. When excess water is present some of the ferrocyanide ions could also get hydrated and thus donate electrons to the conduction band with an activation energy $\sim$ 0.3 eV as discussed earlier. If the concentration of excess water is small, it is natural to expect that the former process would predominate as the temperature increases. Thus the difference between the three curves in Figure 3 can be understood. Again the above hypothesis explains why both types of charge carriers appear when there is free interstitial water.

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# A STUDY OF INCIDENCE OF POULTRY DISEASES AND DISEASE CONDITIONS CAUSING MORTALITY IN COLOMBO REGION

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**Abstract:** This paper describes the incidence of poultry diseases and disease conditions recorded at the Veterinary Investigation Centre, Welisara, during the period 1975 to 1979. It was observed that the incidence of diseases like Pullorum Disease, Chronic Respiratory Disease, Fowl Typhoid and Encephalomalacia declined. Conditions such as Coccidiosis, Chills, Ascaridiasis, Pneumonia, Enteritis, Colibacillosis, and Visceral Gout had variable incidence throughout the period. Incidence of Lymphoid Leucosis, Marek's Disease, Ranikhet Disease, Omphalitis, Infectious Coryza, Aspergillosis and Salt Poisoning were steadily increasing.

## 1. Introduction

A number of poultry diseases in Sri Lanka have been reported by several workers.[1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14] Kulasegaram[5] studied the incidence of diseases of poultry in Sri Lanka for a period from1960 to 1974 based on investigations carried out on poultry carcasses received at the Veterinary Research Institute at Peradeniya. The present study gives the incidence of diseases in poultry for a period of five years from 1975 to 1979 based on investigations carried out at a regional level, at the Veterinary Investigation Centre (VIC), Welisara. This centre is situated in the Western Region of the country, covering the districts of Colombo and Gampaha. In this area, organised poultry farming is based to a large extent on the deep litter system of management. When confronted with diseases leading to mortality, farmers call at the VIC with the carcass of a dead bird for diagnosis and obtain necessary advice for treatment and control of the condition. At this centre an average of 200-300 autopsies were carried out each year during the period of study.

## 2. Materials and Methods

Poultry carcasses received at the VIC were subjected to detail examination. In each instance, a detail history of the affected flock was obtained relating to symptoms, clinical signs, mortality, morbidity pattern, history of

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vaccinations, and treatment. A diagnosis of the disease condition was made on lesions seen at autopsy and laboratory tests where possible. The background history relating to the flock was also taken into consideration. As the recordings were made mainly on examinations of poultry carcasses, the incidence recorded were conditions causing mortality and such conditions like Avitaminosis and Fowl Pox could not be represented well.

In confirming the diagnosis, available laboratory tests were done. When Coccidiosis were suspected, on typical lesions on intestine, a scraping was taken from intestinal mucosa and examined under the microscope for the relevant stages of development of the coccidia.

In Pullorum Disease when typical lesions were seen, the Rapid Slide Test was done from blood drawn from the heart. Also, *Salmonella* organisms were isolated by culturing from swabs taken from the intestine, on MacKonkey agar and 'stabing' the white colonies on Triple Sugar Iron medium. Black colouration in the butt shows $H_2S$ production to presence of *Salmonella* organisms and *Proteus* spp. *Proteus* was eliminated by Urease Test. Typing was not done as specific antisera were not available.

Chronic respiratory Disease due to *Mycoplasma gallisepticam* was suspected on typical lesions on air sacs, lungs, trachea, sinuses and on visceral organs. Also, clinical signs, symptoms, pattern of disease and history of flock were taken into consideration. It was seen mostly in flocks of adult birds reared on damp litter.

Diagnosis of cases of Chills were established from the presence of typical distension of gall bladder along with congestion of lungs, sometimes with nephritis. Also, the history of the flock was taken into consideration.

Lymphoid Leucosis was suspected on typical post mortem lesions and history of the flock.

Ascaridiasis was diagnosed on the presence of *Ascaridia* adult stage.

Marek's Disease was suspected on typical post mortem lesions and clinical signs of leg weakness, distension of crop, dropping of feathers due to skin lesions, etc.

Ranikhet Disease was suspected on pathognomic post mortem lesions like pinpoint haemorrhage in proventriculus, necrotic patches on intestines among other lesions and history including symptoms.

Fowl Typhoid was suspected on typical pathognomic lesions such as bronze colouration and enlargement of liver among other lesions. *Salmonella* organisms were isolated on MacKonkey agar but no typing of the species was done due to non-availability of antisera.

Omphalitis is a pathological condition due to infection of yolk sac with a variety of organisms found in the environment. A normal yolk sac is absorbed 24–48 hours after hatching. An infected yolk sac is seen for sometime after hatching.

Infective Coryza was established when mucoid nasal discharge sometimes with swelling of eyelids , pasting of eyelids and cheesy materials between the eyelids. No other organ was affected. Direct smears and sometimes culture on blood agar, Gram negative rods were seen.

When Aspergillosis was diagnosed, a white nodule or a concave disc was cultured on Sabouraud Medium. After 24 hours abundant growth was seen. The fungus was identified under microscope.

Encephalomalacia due to low vitamin E feed was established on typical 'bicycling' movements of the legs. In all cases vitamin E was introduced to feed and the spread of the disease was arrested.

Colibacillosis was diagnosed on typical characteristic lesion where the heart is covered with a gelatinous mass under the pericardium due to fibrinoid pericarditis. The affected birds were 4–6 months of age mostly with a complaint of losing one or two birds a week. In such cases *Escherichia coli* was isolated on MacKonkey Agar.[3]

Salt Poisoning was established when there was generalised oedema of the carcass with history of giving ration high in common salt. The most common source was addition of powder residue of dry fish as a source of fish meal.

### 3. Results and Discussion

A total of 49 conditions were recorded during the five year period from 1975 to 1979. The number of conditions recorded each year is shown in Table 1.

Table 1. – No. of autopsies and no. of conditions recorded

| | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|
| No. of autopsies | 198 | 297 | 220 | 304 | 195 |
| No. of conditions | 31 | 40 | 30 | 30 | 29 |

The percentage incidence of each condition per year and the average of these percentages for five years were determined as shown in Table 2. On this, the incidence of diseases were classified as (1) High (5% to 12%), (2) Moderate (3% to 5%), (3) Low (1% to 3%) and (4) Very Low (below 1%).

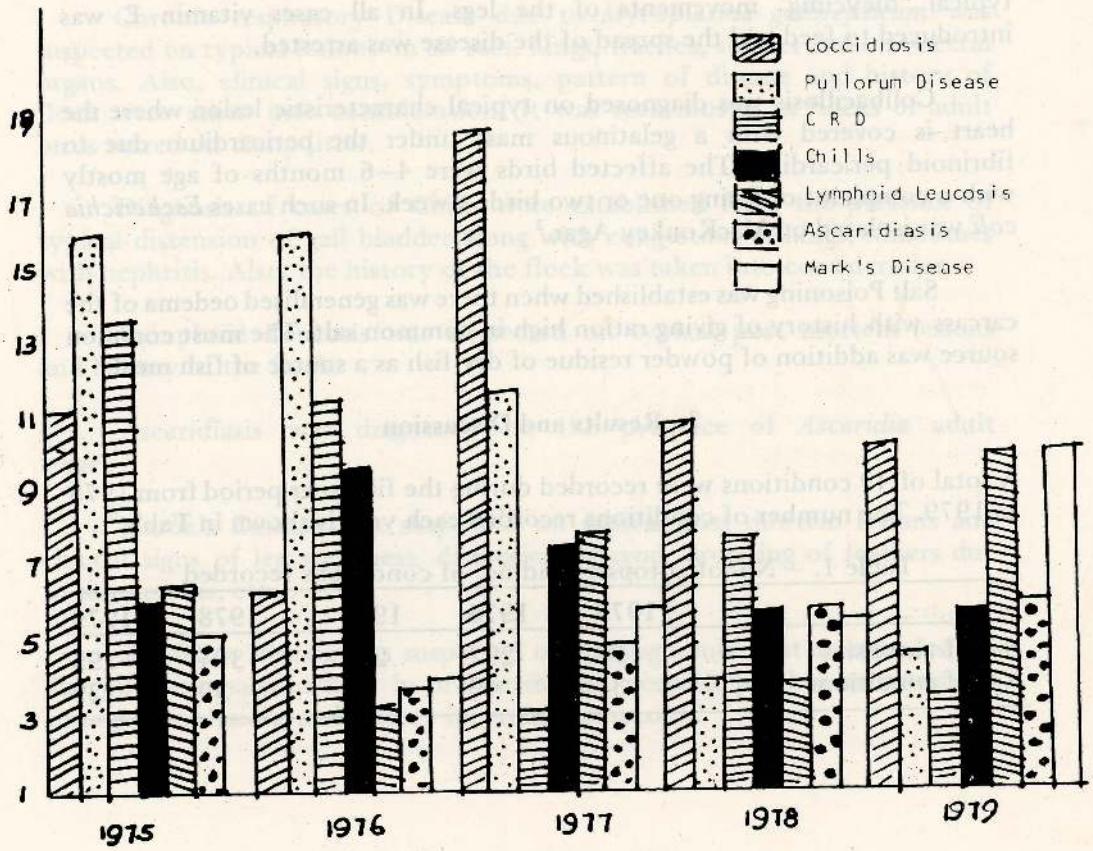


Fig. 1. Diseases of High Incidence.

### 3.1 Diseases and Disease Conditions of High Incidence

Figure 1 shows the distribution. Coccidiosis recorded the highest average incidence during the five year period (Table 2). Its incidence was high throughout the period and was the highest in 1977, 1978 and 1979. This seems to be the general pattern of the disease in this country since 1960.[5] However incidence recorded by Kulasegaram is slightly higher (average incidence 15.3%) and this may be due to climatic differences of the two regions compared. A limitation for control of Coccidiosis was referable mainly to non-availability of variety of effective coccidiostats in the market. The most commonly used Coccidiostat was Zoalene and this too was not available all the time during this period.

Pullorum Disease had the second highest incidence. It was observed that the incidence was quite high in 1975, 1976 and 1977, giving as high as 16.2% in 1975 and gradually going down to 4.6% in 1979. Due to a very high demand for day old chicks, a large number of small time hatcheries opened up during the early seventies. Due to poor management levels in such small holdings, there was high incidence of the disease and later with some experience in hatchery hygiene such conditions were brought under control. This condition was one of the major conditions causing high mortality of day old chicks in the first few weeks of life. It responded well to treatment with Furazolidone combined with Chloramphenicol.

Chronic Respiratory Disease due to *Mycoplasma gallisepticum* comes third highest average incidence during the period of study. It was seen mostly in adults and growing birds, especially during the rainy seasons in poultry houses which are not well protected against rain. Once the disease has set in, it was difficult to control. More effective drugs such as tylosin (Tylan -Elli Lilly) and Spiramycin (M & B) were not imported to the country during the period of study.

Deaths due to chills during the first few weeks of life was quite a problem and it caused heavy mortality and was due to bad management practices. Though the average incidence recorded was 7.2%, it was below this since 1978.

Lymphoid Leucosis had the fifth highest average and there was a tendency for increase since 1979 with an incidence of 10.3%.

Incidence of Ascaridiasis appears to be quite uniform during the period of study as was observed by Kulasegaram.[5] This was probably due to a dynamic equilibrium that has been reached at the present level of manage-

ment, environment and use of piperazine compounds in the treatment. It should be noted that in the present study, whenever Ascarids were seen at the autopsy, it was recorded irrespectively whether it was the primary cause or not of the condition causing death. Hence the incidence of Ascaridiasis shown does not reflect the actual incidence of the disease due to Ascaridiasis.

Marek's Disease was not seen in 1975. Kulasegaram[5] recorded several outbreaks in 1974 while no cases were seen upto 1973. In this study it was observed in 1976 and the incidence went up in the later years.

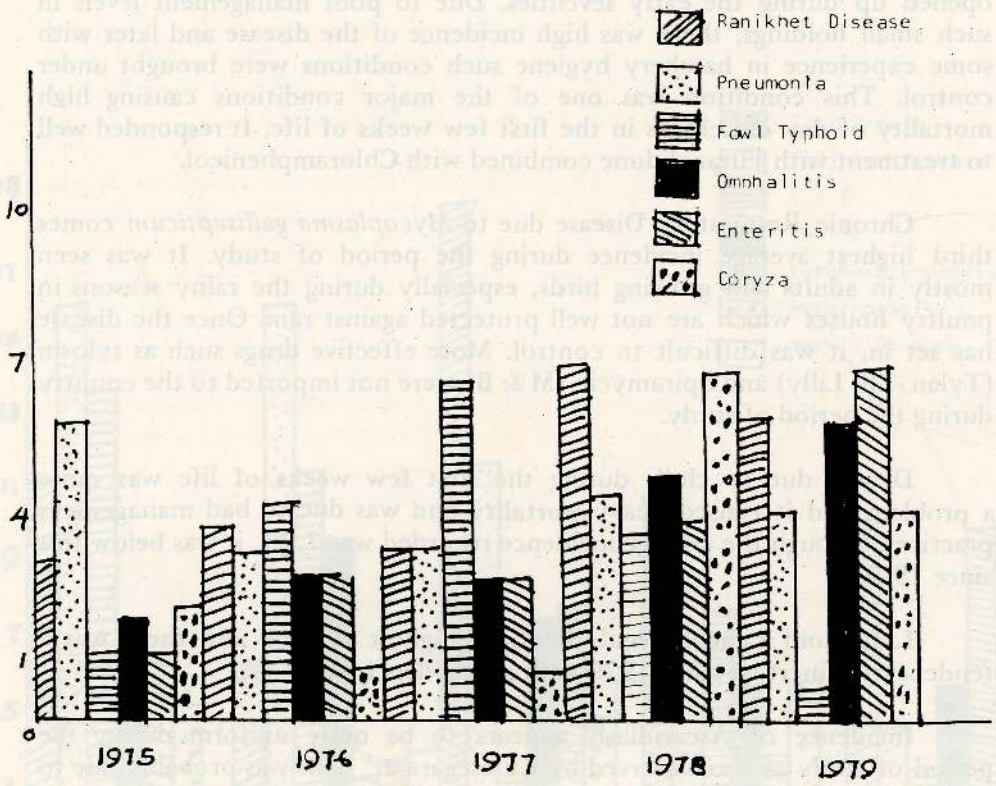


Fig. 2. Diseases of moderate incidence.

### 3.2 Diseases And Disease Conditions of Moderate Incidence

Figure 2 shows the distribution of the diseases.

Once a major disease in poultry in this country causing heavy mortality, Ranikhet Disease had only a moderate incidence and the average incidence was 4.9%. Kulasegaram[5] who reported high incidence of 12% to 10% in 1960 and 1961 respectively. The disease was seen only in non-vaccinated birds.

Pneumonia due to non specific causes such as the result of lowering of resistance in case of Vitamin A deficiency, poor management and feeding was recorded quite uniformly throughout the period.

Fowl Typhoid was suspected in 4.4% cases in 1976 and in 3.8% in 1978, though this condition was not recorded in this country earlier, there was sufficient evidence to suspect this condition.

Omphalitis showed a steady increase in incidence from 1975 to 1979. This may be due to increase in number of hatcheries that had come up to supply the great demand for chicks and the management and the hygienic practices in these hatcheries were not upto the required standard.

Infectious Coryza due to *Haemophilus gallinarum* showed a lower incidence at the beginning but showed a steady increase from 1975 to 1979. In Kulasegaram's study[5] it was the most predominant type of respiratory disease. This is probably due to climatic differences of the two regions.

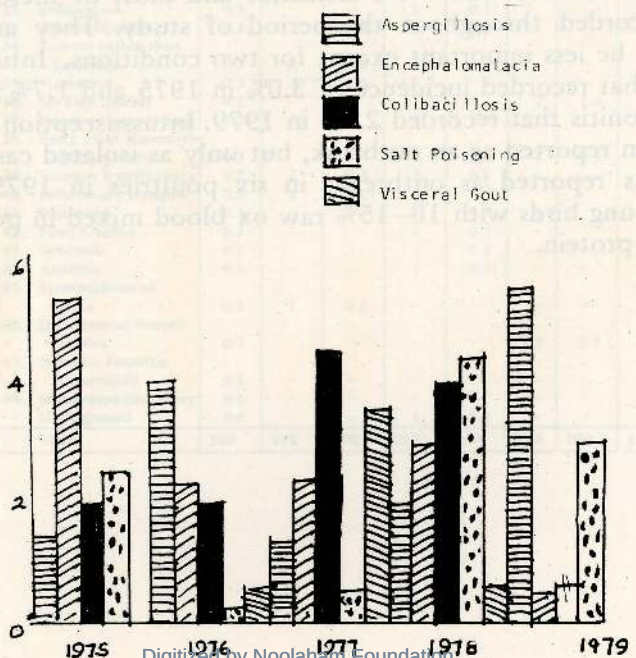




Fig. 3. Diseases of low incidence.

### 3.3 Diseases And Disease Conditions of Low Incidence

Figure 3 shows the distribution of diseases of low incidence.

Aspergillosis showed a steady increase in incidence during the five year period. Though there was a fairly high incidence of Encephalomalacia at the beginning of the period, it reached lower levels during the latter periods. This may be attributed to the fact that the poultry feed was not stored for a long time so as to prevent the destruction of Vitamin E in it as there was a great demand for poultry feed towards the end of this period of study.

Incidence of Colibacillosis gradually increased till 1978. But no cases were recorded in 1979. Most commonly affected were the birds in the four to six months of age and the usual complaint was that one or two birds died every week. The characteristic lesion seen at the autopsy was peri-hepatitis with a gelatinous covering of the liver and fibrino-gelatinous material surrounding the heart due to pericarditis. Response to Furazolidone treatment was very satisfactory.

A fluctuating increase of salt poisoning was seen throughout this period. This condition was mainly caused by use of 'dry fish' powder which has high salt content as a source of fish meal in the ration.

### 3.4 Diseases And Disease Conditions of Very Low Incidence

These include diseases below 1% incidence and most of these conditions were not recorded throughout the period of study. They are generally considered to be less important except for two conditions, Intussusception of Intestine that recorded incidence of 3.0% in 1975 and 1.7% in 1976 and Chronic Peritonitis that recorded 2.6% in 1979. Intussusception of intestine has never been reported as an outbreak, but only as isolated cases. But this condition was reported as outbreaks in six poultries in 1975[1-5] due to feeding of young birds with 10—15% raw ox blood mixed in poultry mash as a source of protein.

Table 2 – LIST OF POULTRY DISEASES AND DISEASE CONDITIONS AND INCIDENCE RECORDED FOR 5 YEARS PERIOD (1975 – 1979)

| Group | No. | Condition | Av.% 5 yrs. | 1975 | | 1976 | | 1977 | | 1978 | | 1979 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1) Disease Conditions and Diseases of High incidence | 1. | Coccidiosis | 11.8 | 23 | 11.6 | 19 | 6.4 | 42 | 19.1 | 34 | 11.2 | 21 | 10.8 |
| | 2. | Pullorum Disease | 10.5 | 32 | 16.2 | 45 | 15.6 | 26 | 11.8 | 13 | 4.3 | 9 | 4.6 |
| | 3. | Mycoplasmosis (CRD) | 8.0 | 27 | 13.6 | 34 | 11.4 | 7 | 3.2 | 25 | 8.2 | 7 | 3.6 |
| | 4. | Chills | 7.2 | 12 | 6.1 | 29 | 9.8 | 17 | 7.7 | 19 | 6.3 | 12 | 6.2 |
| | 5. | Lymphoid Leucosis | 6.6 | 13 | 6.6 | 10 | 3.4 | 18 | 8.2 | 13 | 4.3 | 20 | 10.3 |
| | 6. | Ascaridiasis | 5.3 | 10 | 5.1 | 11 | 3.7 | 11 | 5.0 | 19 | 6.3 | 12 | 6.2 |
| | 7. | Marek's Disease | 5.2 | 2 | 1.0 | 12 | 4.0 | 13 | 5.9 | 18 | 6.0 | 18 | 9.2 |
| 2) Disease Conditions and Diseases of Moderate incidence | 8. | Ranikhet Disease | 4.9 | 7 | 3.5 | 12 | 4.0 | 8 | 3.6 | 22 | 7.2 | 12 | 6.2 |
| | 9. | Pneumonia | 4.4 | 12 | 6.1 | 11 | 3.7 | 8 | 3.6 | 14 | 4.6 | 8 | 4.1 |
| | 10. | Fowl Typhoid | 4.1 | 3 | 1.5 | 13 | 4.4 | 13 | 5.9 | 9 | 3.8 | 1 | 0.5 |
| | 11. | Omphalitis | 3.8 | 4 | 2.0 | 9 | 3.0 | 6 | 2.7 | 15 | 5.0 | 12 | 6.2 |
| | 12. | Enteritis | 3.7 | 3 | 1.5 | 9 | 3.0 | 6 | 2.7 | 12 | 4.0 | 14 | 7.2 |
| | 13. | Coryza | 3.1 | 5 | 2.5 | 3 | 1.0 | 2 | 0.9 | 21 | 7.0 | 8 | 4.1 |
| 3) Disease Conditions and Diseases of low incidence | 14. | Aspergillosis | 2.9 | 3 | 1.5 | 12 | 4.0 | 3 | 1.4 | 6 | 2.0 | 11 | 5.6 |
| | 15. | Encephalomalacia | 2.8 | 11 | 5.6 | 7 | 2.4 | 5 | 2.3 | 9 | 3.0 | 1 | 0.5 |
| | 16. | Colibacillosis | 2.3 | 2 | 1.0 | 6 | 2.0 | 10 | 4.5 | 12 | 4.0 | | |
| | 17. | Salt Poisoning | 2.2 | 5 | 2.5 | 1 | 0.3 | 1 | 0.5 | 13 | 4.3 | 6 | 3.0 |
| | 18. | Visceral Gout | 1.4 | 2 | 1.0 | 2 | 0.7 | 8 | 3.6 | 5 | 1.6 | 0 | 0 |
| 4) Disease Conditions and Diseases of very low incidence | 19. | Intussusception of Intestine | 1.0 | 6 | 3.0 | 5 | 1.7 | 1 | 0.5 | | | | |
| | 20. | Tape worms | 1.0 | 2 | 1.0 | 4 | 1.3 | 2 | 1.0 | 2 | 0.7 | 2 | 1.0 |
| | 21. | Chronic Peritonitis | 0.8 | – | – | 1 | 0.3 | 2 | 1.0 | 1 | 0.3 | 5 | 2.6 |
| | 22. | Sinusitis | 0.8 | – | – | 6 | 2.0 | – | – | 2 | 0.7 | 3 | 1.5 |
| | 23. | Post vaccination reaction | 0.6 | – | – | 5 | 1.7 | 1 | 0.5 | – | | 2 | 1.0 |
| | 24. | Haemorrhagic Syndrome | 0.6 | 2 | 1.0 | 1 | 0.3 | 1 | 0.5 | 3 | 1.0 | | |
| | 25. | Chronic Salphingitis | 0.6 | 1 | 0.5 | – | – | 2 | 1.0 | 3 | 1.0 | 1 | 0.5 |
| | 26. | Heterakis infestation | 0.5 | 2 | 1.0 | 1 | 0.3 | 1 | 0.5 | 2 | 0.7 | | |
| | 27. | Strangulation of intestine | 0.5 | – | | 6 | 2.0 | | | 1 | 0.3 | – | |
| | 28. | Cannabalism | 0.4 | 1 | 0.5 | – | – | 1 | 0.5 | 2 | 0.7 | 1 | 0.5 |
| | 29. | Foreign Body in Gizzard | 0.4 | – | | 1 | 0.3 | – | – | 3 | 1.0 | 1 | 0.5 |
| | 30. | Trauma | 0.3 | – | – | 2 | 0.7 | 1 | 0.5 | – | | 1 | 0.5 |
| | 31. | Cloacitis | 0.3 | 1 | 0.5 | 1 | 0.3 | – | – | – | | 1 | 0.5 |
| | 32. | Suffocation | 0.3 | – | – | 1 | 0.3 | – | – | 2 | 0.7 | 1 | 0.5 |
| | 33. | Hjarres Disease | 0.3 | 1 | 0.5 | 1 | 0.3 | – | – | 2 | 0.7 | – | – |
| | 34. | Tumors (other than Leucosis) | 0.3 | 2 | 1.0 | – | – | – | – | 2 | 0.7 | – | – |
| | 35. | Starvation | 0.2 | 2 | 1.0 | – | – | – | – | – | – | – | – |
| | 36. | Six Day Disease | 0.2 | – | – | – | – | 2 | 1.0 | – | – | – | – |
| | 37. | Internal Haemorrhage | 0.2 | – | – | 3 | 1.0 | – | – | – | – | – | – |
| | 38. | Fatty Liver Haemorrhage Syndrome | 0.2 | – | – | 1 | 0.3 | 1 | 0.5 | – | – | – | – |
| | 39. | Vitamin B defficiency | 0.2 | 1 | 0.5 | 2 | 0.7 | – | – | – | – | – | – |
| | 40. | Infectious Laryngitis | 0.2 | 3 | 1.0 | – | – | – | – | – | – | – | – |
| | 41. | Poisoning | 0.1 | – | – | 2 | 0.7 | – | – | – | – | – | – |
| | 42. | Fowl Cholera | 0.1 | – | – | 2 | 0.7 | – | – | – | – | – | – |
| | 43. | Synovitis | 0.1 | – | – | 1 | 0.3 | – | – | – | – | – | – |
| | 44. | Anaemia | 0.1 | – | – | 1 | 0.3 | – | – | – | – | – | – |
| | 45. | Strangulation of Caeca | 0.1 | 1 | 0.5 | – | – | – | – | – | – | – | – |
| | 46. | Dilatation of Proventriculus | 0.1 | – | – | – | – | 1 | 0.5 | – | – | – | – |
| | 47. | Necrotic Enteritis (Clostridial) | 0.1 | – | – | – | – | – | – | – | – | 1 | 0.5 |
| | 48. | Indigestion (in turkey) | 0.1 | – | – | – | – | – | – | – | – | 1 | 0.5 |
| | | Undiagnosed | 0.4 | – | | 1 | 0.3 | – | – | – | – | 3 | 1.5 |
| | | Total | 100 | 198 | 100 | 297 | 100 | 220 | 100 | 304 | 100 | 195 | 100 |

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# ISOLATION AND CHARACTERIZATION OF YEASTS OF SOME FRUITS AND FRUIT PRODUCTS OF SRI LANKA

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**Abstract:** Thirty six strains of yeasts isolated from some fruits and fruit products were identified using their biochemical and morphological characteristics. These yeasts belonged to six genera viz: *Candida* (Sixteen strains), *Kloeckera* (nine strains), *Hanseniaspora* (three strains), *Pichia* (four strains), *Saccharomyces* (three strains) and *Torulopsis* (one strain). The most predominant species was *Candida krusei* (Ten strains).

## 1. Introduction

Microbial spoilage of food is commonly the result of the combined activities of yeasts, moulds and bacteria. However, depending upon the environment, one of these groups of microbes may prevail over the others. Yeasts ordinarily do not compete well in mixed populations, and therefore, cause spoilage only under conditions which are favourable for their growth, but unfavourable for growth of most bacteria.[1 1] The most important factors which determine the ability of yeasts to compete with moulds and bacteria are the number and types of contaminating yeasts, available nutrients, pH, redox potential and water activity.[2] Spoilage of fresh fruits and vegetables by yeasts usually result from their fermentative activity rather than degradation of plant tissue with degradative enzymes. However, some yeasts are reported to be capable of producing such enzymes and cause spoilage.[3]

Sri Lanka produces a variety of tropical fruits, and also, possesses a rapidly developing fruit processing industry. However, a considerable amount of the produce is lost due to post harvest deterioration where microbial attack is suspected to be one of the predominant causes. In the present study an attempt was made to isolate and characterize the yeast flora of some local fruits and fruit products which may play a role in their spoilage.

## 2. Experimental

Random samples (about 10 each) of fresh ripe fruits (except dates and raisins, which were dried), canned fruits, juices, syrups and cordials were

obtained from retail sellers, canneries and supermarkets of Colombo. These samples included fruits of papaw, grape, date, tomato, passion fruit, lime, pineapple, nelli, raisin, plum, banana, amberella, grapefruit, tangerine, lawulu and mango, and papaw juice, grape-juice, pineapple-juice, nelli-juice, mango-juice and passion fruit cordial (Botanical names of fruits are given in Table 1).

Table 1 – Botanical names of fruits

| | | |
|---|---|---|
| Papaw | – | *Carica papaya* |
| Grapes | – | *Vitis vinifera* |
| Dates | – | *Phoenix dactylifera* |
| Tomatoes | – | *Lycopersicum esculentam* |
| Passion fruit | – | *Passiflora edulis* |
| Lime | – | *Citrus aurantifolia* |
| Pineapple | – | *Ananas sativus* |
| Nelli | – | *Philanthus emblica* |
| Raisin | – | *Vitis vinifera* |
| Plums | – | *Prunus domestica* |
| Plantains | – | *Musa sapientum* |
| Ambarella | – | *Spondias mangifera* |
| Grape fruit | – | *Citrus decumana* |
| Tangerine | – | *Citrus nobilis* |
| Lawulu | – | *Chrysophylla sp.* |
| Mango | – | *Mangifera indica* |

Yeasts were isolated by plating on a medium which had the following composition in g litre$^{-1}$ of distilled water : glucose 20.0, yeast extract 3.0, peptone 5.0 and agar 20.0. Plating was done by streaking a loopful from enrichment cultures prepared by inoculating small amounts (about 1–2 g) of the sample into tubes containing broth of the same medium less agar. Cultures were incubated at room temperature for 2–4 days depending on growth. Methods used to study the biochemical and morphological characteristics were same.[4] The following criteria were used to characterize and identify the isolated yeasts: fermentation pattern, assimilation pattern, morphology and sporulation. Some of these criteria were represented by codes.[13]

## 3. Results and Discussion

In this study thirty six strains of yeasts were isolated and identified. These thirty six strains of yeasts belonged to the six genera *Candida, Kloeckera, Hanseniaspora, Pichia, Saccharomyces* and *Torulopsis.* The predominant species were *Candida krusei* (ten strains) and *Kloeckera apiculata* (seven

strains). The morphological and biochemical characteristics of these strains and their sources of isolation together with their completed identification codes[13] are given in Table 2.

*Candida krusei* the most predominantly encountered in this study was isolated on eight occasions from fresh fruits and in two occasions from dried fruits (Date and Raisin). Mrak *et al*[7] and Miller and Mrak[12] has listed *Candida krusei* as one of the most numerous yeasts in spoiled figs. A strain of *Candida tamarandei* which is synonymous with *Candida krusei* has been isolated from fermenting date.[14] Another species, *Candida guilliermondii* two strains of which were isolated from papaw juice and grape juice in this study has been earlier isolated from fig wasps.[14] *Candida mesenterica* (three strains) and *Candida peliculosa* (one strain) which also were encountered in this study have not been isolated from fruits earlier.

*Kloeckera apiculata,* of which seven strains were isolated from fruits in this study, has been earlier reported[8] to cause softening in strawberries. This also has been reported as the only yeast isolated from blackcurrents picked at the end of the harvesting period.[3] Also, *Kloeckera apiculata* has been reported much earlier under the synonym *Saccharomyces apiculatus* as an organism widely distributed in fruits and orchards.[10] Next to *Saccharomyces cerevisiae* this species has been reported to be the most prominent in wine grapes.[9] Another species *Kloeckera africana,* isolated from Lawulu (two strains) has earlier been isolated from figs.[9]

*Saccharomyces cerevisiae* which is generally a common contaminant in many food products was encountered only once in this study (one strain from Tomato sauce). Two other species, *Saccharomyces exiguus* and *Saccharomyces italicus* a strain each of which was isolated from nelli juice and mango juice respectively has earlier been reported as a contaminant in grape must.[5]

Among the other yeasts encountered in this study which have been reported earlier are *Hanseniaspora valbyeansis*[6] (wine grape) and *Pichia fermantans*[1] (orange juice). None of the other yeasts *(Pichia polymorpha, Pichia kuriavzevii* and *Torulopsis inconspicua)* have been reported as contaminants of fruits earlier.

Table 2 – Identification of Yeasts from Fruits & Food Products

| Fermentation Code[a] | Assimilation | | | Morphology | | | | | Code[a] | Completed Code[a] | Strain |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ethanol | Nitrate | Sugar Code[a] | Cell shape | Ascospore | Ps | My | Pe | | | |
| GA | + | 0 | 4 | short-ovoid, ovoid | – | + | – | + | 2 | GA/04/2 | *Candida guilliermondii* (Pj1, Gj1) |
| D | – | 0 | 1 | Lemon-shaped, ovoid or elongate | – | – | – | – | BB | D/01/BB | *Kloeckera apiculata* (p1, Pf1, Pa1, Pap1, Paj1, Pla1, Ta1) |
| D | – | 0 | 1 | Oval, apiculate or elongate | Hat-shape or ovoid | – | – | – | BB | D/01/BB | *Hanseniaspora valbyensis* (P1, M1, T1) |
| D | + | 0 | 1 | Cylindrical or ovoid | – | + | – | + | 2 | D/01/2 | *Candida krusei* (D1, M1, Ti, P1, G1, Pf1, L1, R1, Am1, Grp1) |
| O | + | 0 | 1SM | Ovoid, elongated | – | + | + | + | 2 | 0/01SM/2 | *Candida mesenterica* (G1, L1, Mj1) |
| D | + | 0 | 5 | Oval, cylindrical | Spherical | + | – | + | 2 | D/05/2 | *Pichia polymorpha* (D1) |
| D | + | 0 | 1 | Oval, long oval | Spherical | + | – | + | 2 | D/01/2 | *Pichia kudriavzevii* (T1, Pl1) |
| GMA | – | 0 | 4 | Spheroidal, subglobose or cylindrical | Spheroidal | + | – | – | 1 | GMA/04/1 | *Saccharomyces cereviseae* (Ta1) |
| D | + | 0 | 1 | Ovoid | – | + | – | – | 1 | D/01/1 | *Torulopsis inconspicua* (Pfc1) |
| GMA | + | N | 4 | Ovoid, Elipsoidal | – | + | – | + | 2 | GMA/N4/2 | *Candida peliculosa* (Pap1) |
| GA | + | 0 | 3 | Spheroidal, ellipsoidal | Spheroidal | – | – | + | 1 | GA/03/1 | *Saccharomyces exiguus* (Nj1) |
| D | – | 0 | 1SM | Ovoid, Elongated | – | + | – | – | BB | D/01SM/BB | *Kloeckera africana* (La2) |
| GMS | + | 0 | GMS | Spheroidal, subglobose | Spheroidal | + | – | – | 2B | GMS/04/2B | *Saccharomyces italicus* (Mj1) |
| D | + | 0 | 1 | Oval to long-oval | Spherical | + | – | + | 2 | D/01/2 | *Pichia fermentans* (G1) |

Abbreviations: Ps, Pseudomycelium; My, Mycelium; Pe, Pellicle; Pj, Papaw juice; P, Papaw; G. Grapes; Gy, Grape juice; D, Dates; T, Tomato; Ts, Tomato source; Pf, Passion fruit; Pfc, Passion fruit cordial; L, Lime; Pa, Pineapple; Pap, Pineapple pulp; Paj, Pineapple juice; Nj, Nelli juice; R, Raisin; Pl, Plums; Pla, Plantains; Am, Ambarella; Grp, Grape fruit; Ta, Tangerine; La, Lawulu; M, Mango; Mj, Mango juice; Gl, Glucose; Ga, galactose; Su Sucrose; Ma, Maltose; Ra, Raffinose; Eth, Ethanol; $KNO_3$, Potassium nitrate.

Code[a]: (Based on method by Beach et al)

Sugar Fermentation :

O –: No. Fermentation; D–: Gl; Su, Ma, Ra; Ms–: Gl, Su, Ma; A–: Gl, Su, Ra; GA–: Gl, Ga, Su; GMA–: Gl, Ga, Su, Ma, Ra; GMS–: Gl, Ga, Su, Ma

Nitrate Assimilation:

N–: Assimilation; O–: No assimilation

Sugar Assimilation:

1SM–: Gl, Su, Ma, Ra. 1–: Gl only; 3–: Gl, Ga, Su, Ra; 4–: Gl, Ga, Su, Ma, Ra

Morphology Code :

1–: Multilateral budding, No pseudomycelium, No pellicle; 2–: Multilateral budding, with pseudomycelium with pellicle; 2B–: Multilateral budding with pseudomycelium, No pellicle; BB–: Bipolar budding.

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# DESIGN REQUIREMENTS AND DIMENSIONS FOR A COMFORTABLE WORK SEAT FOR SRI LANKANS

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**Abstract:** Uncomfortable workseats are a common sight in many work places today. Sitting at work on a comfortable seat helps to relax the body and reduce energy consumption, but on the other hand prolonged sitting slackens abdominal muscles and may cause backache. An optimum work seat can be made if proper medical and ergonomic ideas are applied in the design. The data on body sizes of the users are important to design an optimum work seat. A National Anthropometric (body sizes) Survey has provided this data. Based on this data, recommended dimensions for a work seat are as follows :

| | Males | Females |
|---|---|---|
| Seat Height (from floor) | 39.5 cm | 36.4 cm |
| Back rest Height (from seat) | 44.9–46.9 cm | 40.4–42.4 cm |
| Back rest Breadth | 37.0 cm (29.0 cm minimum) | 33.3 cm (25.3 cm minimum) |
| Lumbar support Height (from seat) | 16.4–26.5 cm | 16.1–25.8 cm |
| Seat Width | 39.7 cm (27.7 cm minimum) | 40.0 cm (28.0 cm minimum) |
| Seat Depth | 36.3–41.3 cm | 34.2–39.2 cm |
| Arm rest Height (from seat) (for armed chairs) | 19.8 cm | 18.5 cm |

The other important recommendations are a backward tilt of the seat surface of $14 - 24^{\circ}$ to the horizontal, to prevent buttocks sliding forwards, a lumbar support on the back rest and an inclined back rest of $105 - 110^{\circ}$ to seat or $110 - 130^{\circ}$ to the horizontal.

## 1. Introduction

Many problems of mismatch between the man and his work tools and machines including furniture are a common sight in Sri Lankan factories and work places. Discomfort, body pain, inefficiency, delay and wastage are some results of these wrongly designed work aids.

A work seat may be called an essential requirement for most workers either to perform work with less fatigue or as an aid for relaxation. It also improves their well-being and efficiency if people sit at their work. Static muscular effort which is required for a standing person ceases when the

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person sits down. The other advantages of sitting are, it takes the weight off the legs, reduces energy consumption and avoids unnatural body postures. There are also drawbacks such as slackening of abdominal muscles due to prolonged sitting and curvature of spine that may cause inter-vertebral disc pressure[4] resulting in backache. In order to maximise the advantages and to minimise the drawbacks it is important to apply medical and ergonomic ideas in the design of seats for work.

In the application of ergonomic principles in the design of a work seat, greater emphasis has to be given to the body sizes of the users.

## 2. Method

A National Anthropometric Survey[1] (Body Sizes Survey) was conducted in Sri Lanka on 438 male workers and 288 female workers. The subjects taken for the measurements included workers from 80 work establishments from 24 districts in Sri Lanka.

A standard anthropometer and an adjustable chair were used to take most measurements. Vernier calipers and tapes (canvas and metallic) were used to take few measurements. Measurements were carried out by specially trained technicians and included among other measurements all important dimensions required to design a seat.

The anthropometer is a counter recording instrument which can be effortlessly operated from the tips of its branches. This instrument gives a direct and accurate reading, to the nearest millimeter over a range of 50 mm. Each instrument has straight and recurved branches and beam extensions for the measuring of heights of up to 3 meters.

Each subject was required to sit on the adjustable chair and the seat was adjusted till the seat gave the worker maximum comfort.

The seat gives maximum comfort when the subject sits comfortably erect on the adjustable chair with the trunk straight, the back of the head and buttocks pressing firmly against the walls of the chair. The stool height is adjusted so that the upper part of the leg is horizontal to the floor. The lower part of the thigh at the back of the knee not pressing on the edge of the chair but leaves a small space between the leg and the chair, the feet flat on the floor and the shins verticle.

## 2.1 Description of Measurements and their significance and recommended Measurements

*2.1.1 Seat Height :* This is the vertical height of the sitting surface from the floor, when the subject is comfortably seated erect. (Figure 1)

Any good design should accommodate about 90% of the population. It would be practically difficult to accommodate the extremes of the population, i.e. the 5% very short people and 5% very tall people. Therefore in deciding the height of a seat the mean sitting height of the population is the most convenient height, if the height is fixed (not adjustable). On the other hand if the seat is adjustable the maximum height should be the height of 95th percentile of the population and the minimum height should be the height of 5th percentile of the population. If however a high seat is required depending on the operating height, a foot rest has to be provided to counter-balance the extra height. Similarly in deciding the seat height, another factor that has to be taken into consideration is the shoe height (which is in the range of 10 – 20 mm) that has to be added to the seat height. Therefore the mean sitting height plus 15mm (for shoes) can be recommended as the seat height.

*2.1.2 Back rest Height :* The part of the human anatomy between the lowest ribs and upper hip bones is suspended by the vertebral bones and is called the lumbar region. For the back to be relaxed and anatomically convenient, this most vulnerable area of the spine viz: the lumbar region, has to be supported by the back rest of the seat. To relax the back muscles where occasional leaning back is necessary, a high back rest, a clear 10 – 12 cm lower than the sitting shoulder height is recommended.

i. Lowest rib bone height, sitting:– Sitting comfortably erect. Measurement from floor to the bottom of the lowest left rib. The lowest left rib is traced by palpating the rib box of the subject. (Figure 2)

ii. Upper hip bone height, sitting:– Sitting comfortably erect. Measurement from floor to the uppermost point of the left hip bone. The hip bone is traced by palpating. (Figure 3).

iii. Shoulder height, sitting:– Sitting comfortably erect. Measurement from floor to center point between base of neck and acromial. (Figure 4)

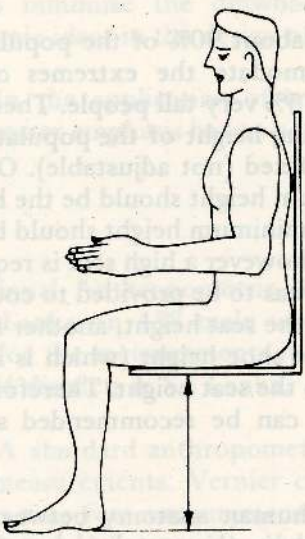


Figure 1. Seat Height

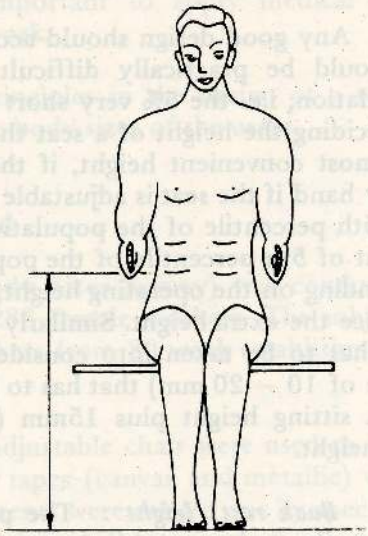


Figure 2. Lowest Rib Height, Sitting

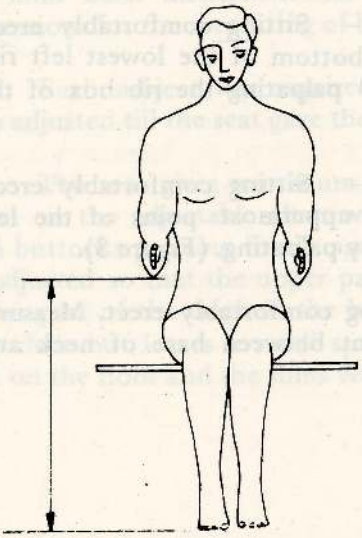


Figure 3. Upper Hip Bone Height, Sitting

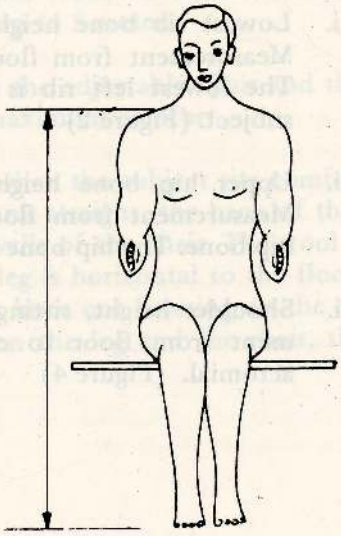


Figure 4. Shoulder Height, Sitting

*2.1.3 Back rest Breadth :* The back rest to be able to accommodate 90% of the population, it is necessary that 95th percentile chest breadth of the population is taken which would be the minimum requirement. However it is recommended that 8 cm are added to the 95th percentile chest breadth to accommodate the area of the back just above the chest and just below the shoulders. The 8 cm was arrived by taking into consideration the shoulder breadth (or biacromial breadth) measurement. (Mean for males – 36.8 cm and mean for females – 33.1 cm).

(i) Chest breadth :– Measurement taken from the front side of the subject, the distance between the widest point across the chest. (Figure 5).

(ii) Biacromial breadth :– Measurement with caliper tips of the anthropometer in firm contact with outer edges of acromial process. (Figure 6).

*2.1.4 Arm rest Height :* The most comfortable position anatomically of the arm rest in a chair is the elbow height, when comfortably seated.

(i) Elbow rest height, Sitting :– Sitting comfortably erect, elbow held lightly against sides with forearms horizontal to the floor. Measurement from floor to the lowest point on the left elbow. (Figure 7).

*2.1.5 Seat Surface Dimensions*

(1) Hip width :– Measurement with caliper tips of the anthropometer in firm contact with the widest points of the hip bones of the two sides. (Figure 8).

The width of the seat to be able to accommodate 90% of the population, it is necessary that the 95th percentile hip width of the population is taken, which will be the minimum requirement. To accommodate the upper legs at different sitting positions, it is recommended that the width of the seat should be 95th percentile dimension of hip width plus 12 cm. The additional space would also allow to accommodate the upper legs at sitting positions with expanded legs. This additional space (12 cm) was arrived by making observations of common sitting postures of workers.

(ii) Buttock to back of knee sitting:– Sitting comfortably erect. Measurement from end wall to furthest point in back of knee. (Figure 9).

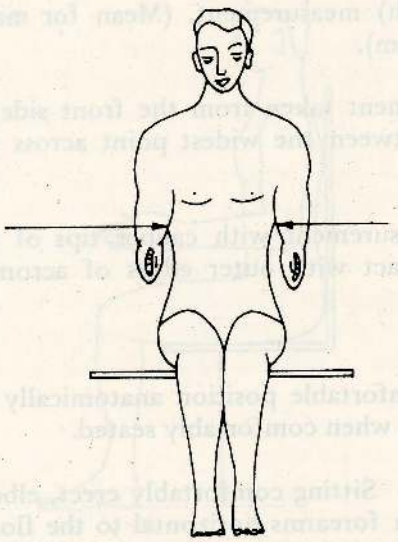


Figure 5. Chest Breadth

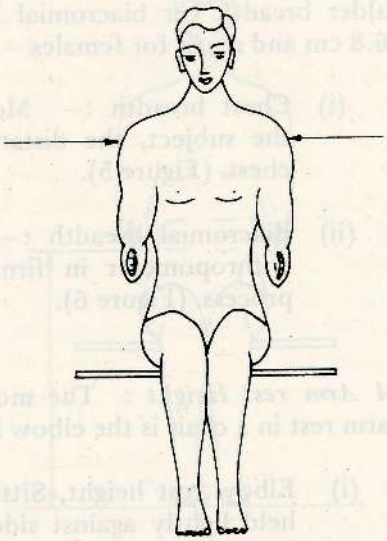


Figure 6. Biacromial Breadth

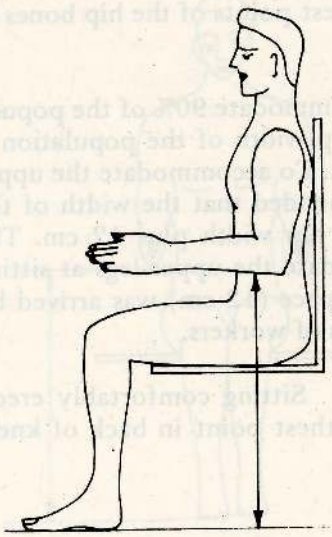


Figure 7. Elbow Height, Sitting

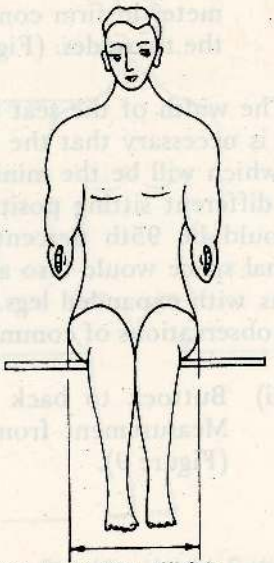


Figure 8. Hip Width

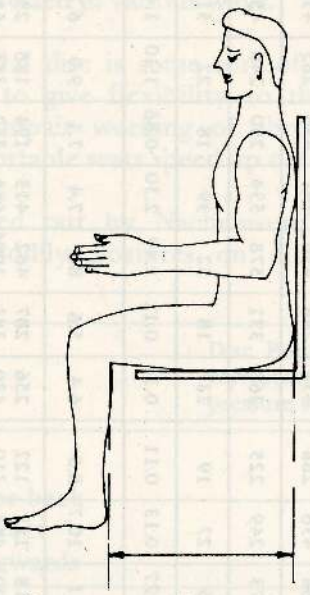


**Figure 9. Buttock to Back of Knee, Sitting**

The depth of a seat should accommodate comfortably the portion of the leg between the buttock and the back of the knee. If the back of the knee presses or touches the edge of the chair or if the depth of the seat is insufficient to accommodate at least 90% of the lower portion of the upper leg, the seat could be uncomfortable. Therefore the mean of this measurement obtained in the national sample would be the maximum depth that could be recommended for a standard comfortable seat. The minimum depth can be 5 cm less than the mean.

## 4. Results

The results obtained from the national survey are shown in Table 1.

Table 1 – Results of Body Dimensions taken with the Subjects Seated Comfortably

| | Height of seat | | Lowest rib Height, Sitting (from floor) | | Upper Hip Bone Height, Sitting (from floor) | | Shoulder Height (from floor) Sitting | | Chest Breadth | | Biacromial Breadth | | Elbow Height, Sitting (from floor) | | Hip Width | | Buttock to back of knee, Sitting | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
| Number of Subjects | 434 | 285 | 435 | 288 | 436 | 287 | 434 | 288 | 436 | 288 | 434 | 288 | 436 | 287 | 436 | 285 | 436 | 288 |
| Mean | 380 | 349 | 645 | 607 | 544 | 510 | 949 | 873 | 249 | 225 | 368 | 331 | 578 | 534 | 250 | 246 | 459 | 446 |
| Standard Deviation | 29 | 24 | 45 | 37 | 43 | 36 | 51 | 45 | 27 | 19 | 23 | 18 | 52 | 39 | 18 | 22 | 31 | 35 |
| Standard Error | 1.39 | 1.42 | 2.16 | 2.18 | 2.06 | 2.13 | 0.24 | 0.27 | 0.13 | 0.11 | 0.11 | 0.11 | 2.49 | 2.30 | 0.86 | 1.30 | 1.48 | 2.06 |
| Coefficient of Variance (Percentages) | 7.6 | 6.9 | 6.9 | 6.0 | 7.8 | 7.1 | 5.3 | 5.1 | 10.7 | 8.5 | 6.4 | 5.6 | 8.9 | 7.4 | 7.1 | 9.0 | 6.7 | 7.9 |
| Range | 208<br>476 | 229<br>419 | 505<br>1021 | 489<br>757 | 402<br>695 | 368<br>621 | 726<br>1221 | 618<br>1003 | 125<br>464 | 122<br>310 | 256<br>430 | 287<br>383 | 462<br>1006 | 413<br>666 | 194<br>312 | 186<br>355 | 233<br>612 | 206<br>522 |
| 5th Percentile | 338 | 316 | 585 | 550 | 485 | 457 | 876 | 811 | 216 | 199 | 331 | 300 | 509 | 470 | 224 | 212 | 416 | 400 |
| 95th Percentile | 423 | 391 | 715 | 669 | 619 | 571 | 1025 | 940 | 283 | 252 | 402 | 361 | 663 | 600 | 280 | 281 | 507 | 494 |

All measurements in millimeters. M – Males. F – Females

Note : Unreliable measurements have been deleted and certain measurements have not been recorded on some subjects. Therefore the number of subjects varies for different measurements.

## 5. Discussion

The part of the body that is affected mostly by stressful work postures is the back. In many sitting positions, the spine and the muscles of the back are not relaxed but stressed in various ways.

An intervertebral disc is some sort of a cushion that separates two vertebrae and helps to give flexibility to the spine. Degeneration of the intervertebral discs impair working of the vertebral column. Unnatural postures and uncomfortable seats speed up deterioration of the discs.[2, 5, 6]

Research carried out by Nachemson,[4] on 9 healthy subjects on effects of various bodily postures on disc pressure has indicated the following results.

| Body Posture | Disc Pressure between 3rd and 4th lumbar vertebrae expressed as a percentage of pressure when standing erect |
|---|---|
| Standing Erect | 100 |
| Lying flat on the back | 24 |
| Sitting, trunk erect | 140 |
| Sitting, bent forwards | 190 |

These results clearly show that disc pressure is greater when sitting than when standing. Further it indicates that a better sitting position is when the trunk is erect than bent forwards.

The most vulnerable part of the spine is the lumbar region as this part suspends between the upper part of the body (heavy) encasing the rib box and the lower part (lighter) starting from the hip bone. Therefore it is most important that this lumbar region has to be supported by the back rest. A lumbar pad of 5 cm thickness is preferable to a flat back rest.[2]

Investigators Anderson et al,[2] Nachemson,[4] and Yamaguchi et al,[6] have studied the effects of seat angle and the shape of the back rest, on disc pressure. The experiments have revealed that the best conditions for relaxation of the spine have been provided by a seat angle to the horizontal of $10°-14°$ and an angle between the seat and the backrest of $115°-120°$.

Grandjeam et al,[3] has studied different seat profiles on a large number of subjects and obtained their subjective impressions. He has found that a seat profile which produces only a low pressure in the intervertebral disc and requires very little static muscular effort, is also the one that causes the fewest aches and pains.

Therefore in designing a work seat, which is good medically and ergonomically and taking these researches as a whole, the following recommendations are made.

(a) Seat surface should be tilted backwards so that the buttocks will not slide forwards. A tilt of 14 – 24° to horizontal has been recommended.

(b) Backrest should be high which is slightly concave to the front at its top end, and distinctly convex in the lumbar region. The backrest should also be inclined at the following angles.

i. to the seat 105 – 110°

ii. to the horizontal 110 – 130°

The above additional design requirements could be made applicable to a comfortable work seat for Sri Lankans.

A prototype Work Seat

In considering the above discussion and based on the data provided by the Anthropometric Survey, the following prototype work seat is recommended. (Figures 10 and 11). Dimensions for seats to be used by males as well as females in Sri Lanka are indicated.

A table to be used with this chair should have a height from the floor to the bottom of the table of 55.8 cm for males and 51.4 cm for females and from floor to the top of table of 59.3 cm for males and 54.9 cm for females. It is also recommended that if a chair is to be provided with arms, the arm rest height from seat should be 19.8 cm for males and 18.5 cm for females. The mean elbow height (seated), has been considered to be the most convenient level for both the table top height (working height) and arm rest height. (1.5 cm for shoes are added to the mean elbow height measurement).

This study however did not examine the prototype chair recommended, subjectively. The seat material characteristics and the effects of the environment are other factors that have to be considered when conducting subjective assessments.

Fig. 10 **WORK SEAT ( Side View )**

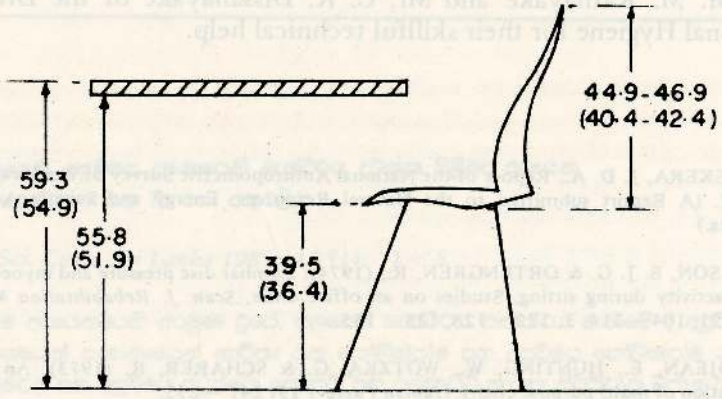
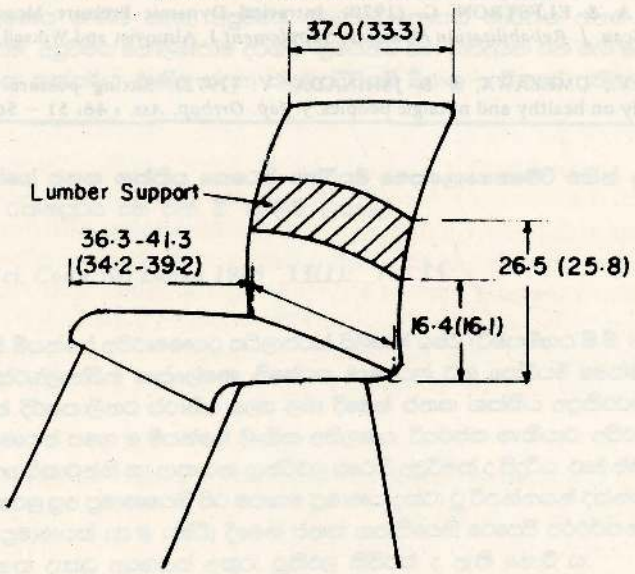



Fig. 11 **WORK SEAT ( Front View )**




All Measurements in Centimeters

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වන්ද්‍රා පී. කොඩිකාර සහ ඩී. එස්. අතුරලිය

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මෙම අධ්‍යයනයෙහි අරමුණ වූයේ, ජලයෙහි බැක්ටීරිය තත්ත්වය මැණිමේ දී අසුවිමය දූෂණයේ දර්ශක වශයෙන් සාමාන්‍යයෙන් භාවිතා වන කෝලිෆෝම සහ අසුවිමය කෝලිෆෝම යන බැක්ටීරිය දර්ශක ක්‍රමවල සහ අසුවිමය ස්ට්‍රප්ටෝ කොකයි සහ සල්ෆයිට් හාරක නිර්පිරානු ඛීජානු (ක්ලොස්ට්‍රීඩියා) ක්‍රමයන්හි වැදගත්කම තත්සේරු කිරීම සඳහා එම ක්‍රම සන්සන්දනය කිරීමයි. මහනුවර ජලය බෙද හැරීමේ පද්ධතියෙන් ලබා ගත් ජල ආදර්ශක 84 ක් මෙහි දී පරීක්ෂණයට භාජනය කරන ලදී. කෝලිෆෝම්, අසුවිමය කෝලිෆෝම සහ අසුවිමය ස්ට්‍රෙප්ටොකොකයි යන දර්ශකයන්ගෙන් දූෂණය වී තිබූ ආදර්ශක ප්‍රතිශතය පිළිවෙලින් 37%ක් 15% ක් සහ 54% ක් විය. පිළියම් කරන ලද නළ ජලයෙහි අසුවිමය දූෂණය මැණිම සඳහා අසුවිමය ස්ට්‍රෙප්ටොකොකයි භාවිතය දැනට අනුගමනය කෙරෙන කෝලිෆෝම්, අසුවිමය කෝලිෆෝම දර්ශක ක්‍රමයනට වඩා වාසිදායක වන බැවි පෙනී ගියේ ය. ජලයෙහි සනීපාරක්ෂක තත්ත්වය මැණීම සඳහා ක්ලොස්ට්‍රීඩියම් බීජානු භාවිතයේ ප්‍රතිඵල අසතුටුදායක විය.

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**පිරිමි මියන්ගේ ජනක ශක්තිය කෙරෙහි සෝඩියම් මෙක්ලොෆෙනමේට් මගින් ඇති වන ආවරණය:**
ඩබ්ලිව්. ඩී. රත්නසූරිය සහ එන්. ඩී. ඩබ්ලිව්. ලියනල්

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පිරිමි මියන්ගේ අපිරාෂණයට සයිලාස්ටික් සිලිකන් යෂ්ඨි (විෂ්කම්භය මි.මී. 3.5 සහ දිග මි.මී. 10-12) මගින් ප්‍රොස්ටග්ලැන්ඩින් සංස්ලේෂණ නිෂේධක ඖෂධයක් වන සෝඩියම් මෙක්ලොෆෙනමේට් 50% ක සාන්ද්‍රණයක් දීර්ඝකාලීනව ස්ථානීය ලෙස ලබා දීමෙන් ජනක ශක්තිය අප්‍රතිවර්ත ලෙස පහත වැටුනි. මෙම ආවරණයත් සමග ම මියන්ගේ ලිංගික අභිලාෂය, විසර්ජක හැකියාව, අපිරාෂණ ශුක්‍රවල වලනාව සහ ශුක්‍ර ආශයිකාවන්හි හා ආතංවන ග්‍රන්ථිවල බරෙහි අඩුවීමක් ද සිදුවිය. එමෙන්ම ශුංගි වෝලයෙහි සහ අණ්ඩ කෝෂවල සුළු ප්‍රමාණයෙහි සිට මධ්‍යයම ප්‍රමාණය දක්වා වූ විපන්නයන් දක්නට ලැබුණි. කෙසේ වුවත් අඩු ඖෂධ ප්‍රමාණයක් (25% යෂ්ඨි) දිමෙන් ජනක ශක්තියෙහි වෙනසෙ පරිවර්තනයක් සිදු නොවූ අතර, එමගින් ඉහත දැක්වූ අයහපත් අතුරු ප්‍රතිඵල කිසිවක් ද ඇති නොවී ය.

**කොළඹ ප්‍රදේශයේ කුකුළන්ගේ මරණයට හේතු දෙන කුකුළු රෝග සහ රෝග තත්වයන් වැළදීම පිළිබඳ අධ්‍යයනයක්**

යූ. පී. ජේ. එස්. වික්‍රමසූරිය, බී.වී.එස්සී (ලංකා) එෆ්. ආර්. වී. සී. (ස්විටන්)

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1975 සිට 1979 දක්වා කාලසීමාව තුළ වැලිසර පශු පරීක්ෂණ මධ්‍යස්ථානයේ වාර්තාගත වී ඇති කුකුළු රෝග සහ රෝග තත්වයන් මෙම ලිපියෙන් විස්තර වෙයි. පුල්ලෝරම් රෝගය, නිදන්ගත ස්වසන රෝගය, කුකුළු උණසන්නිපාතය සහ එන්ඩෝපැල මැලේසියාව වැනි රෝග වැළදීම අඩු විය. කොසිඩියෝසිස්, ශීතල, වටපණු රෝගය, නියුමෝනියාව, එන්ටරයිටිස්, කොලිබැසිලෝසියාව සහ විසරල් ගොට යන රෝග මේ කාලය තුළ විවිධ ප්‍රමාණයට වැළදුනි.

ලිම්ෆොයිඩ් ලියුකොසිස්, මරෙක්ස් රෝගය, රනිකෙට් රෝගය, ඔම්ෆලයිටිස් බෝවන කොරයිසියාව, ඇස්පර්පිලෝසියාව සහ ලුණු වීම වීම සියුයෙන් වැඩි වෙමින් පැවතිණ.

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**තේ පානයෙන් 14C කැෆේන් මියාගේ මූත්‍රා සමඟ බහිස්‍රාවය වීම සහ පටක ව්‍යාප්තිය කෙරෙහි ඇති වන බලපෑම**

ර්. එච්. කරුණානායක සහ එස්. එස්. එස්. බී. වී. පී. සොයිසා

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කැෆේන් (මිතයිල් - 14C බහිස්‍රාවය සහ පටකයන්හි ව්‍යාප්ත වීම කෙරෙහි තේ පානයෙන් ඇති වන බලපෑම පරීක්ෂා කරන ලදි. ගැහැණු සහ පිරිමි මියන්ට මුඛ මාර්ගයෙන් කැෆේපේන් (මිතයිල් - 14C දිමෙන් පසුව විකිරණශීලතාව (ආසන්න ඵශයෙන් පිළිවෙලින් 62% ක් සහ 70% ක්) ප්‍රධාන ඵශයෙන් මූත්‍ර මගින් බහිස්‍රාවය විය. වැඩි ඵශයෙන් ම බහිස්‍රාවය වූයේ පැය 12 - 24 අතර කාල සීමාවේ දී ය. මූත්‍රවල සුළු ප්‍රමාණයක් (ආසන්න ඵශයෙන් පිළිවෙලින් 7% ක් සහ 9% ක්) දක්නට ලැබිණ. ර්ට වෙනස් ලෙස තේ පානය සමග කැෆේපේන් (-මිතයිල් - 14C දුන් විට වැඩි විකිරණශීලතාවයක් (ආසන්න ඵශයෙන් 70% සහ 78%) මූත්‍ර සමග බහිස්‍රාවය විය. මෙහි දී වැඩි ඵශයෙන් ම මූත්‍ර සමග බහිස්‍රාවය වූයේ පැය 12-24 කාල පරිච්ඡේදයේ ය. පටක ව්‍යාප්තිය පිළිබඳ අධ්‍යයනයන්හි දී විශාල වෙනස්කම් දක්නට ලැබිණ. තේ සමග කැෆේපේන් දුන් විට, තනිකර කැෆේපේන් දුන්නාට වඩා උදරයෙහි විකිරණශීලතාව ශීඝ්‍රයෙන් පහත වැටුනි. කැෆේපේන් තේ සමග දුන් විට ර්ට වෙනස් ලෙස රුධිරයේ විකිරණශීලතා පැතිකඩ වඩා දිගි කාලයක් තුළ ඉහල නිශ්චිත ක්‍රියාකාරිත්වයක් පෙන්නුම් කළේ ය. සමස්ථ අධ්‍යයනයන්ගෙන් පෙනී යන්නේ තේ පානය මගින් පටක වලට ඇද ගන්නා කැෆේපේන් ප්‍රමාණය අඩු වී මූත්‍ර බහිස්‍රාවය වැඩි කරන බවයි.

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**කපාපු පොල් සඳහා භාවිතා කෙරෙන ඇසුරුම් ද්‍රව්‍ය තුළින් තෙතමනය අධිශෝෂණය වීම**

යූ. සමරපීව සහ ඩී. කේ. වාමර ඉලේපෙරුම

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ශ්‍රී ලංකාවේ කපාපු පොල් සියයට 3 කට අඩු තෙතමනයක් දක්වා වියලා 85 ක් ඝන වූ අඩු ඝනත්ව පොලිඑතිලීන් වලින් සැදි අභ්‍යන්තර ස්ථරයක් සහිත කඩදාසි ස්ථර පහකින් යුත් මළුවල කි.ග්‍රෑ. 50 බැගින් අසුරනු ලැබේ. ගබඩා කර තැබීමේ දී සහ ප්‍රවාහනයේ දී මෙම මළු මාස කීපයක් මුළුල්ලේ විවිධ සාපේක්ෂ ආද්‍රතාවනට නිරාවරණය වීමෙන් කපාපු පොල්වලට තෙතමනය අධිශෝෂණය වෙයි.

සියුම් වර්ගයේ කපාපු පොල් (ග්‍රෑ 10 ක්) අඩු ඝනත්වයේ පොලිඑතලීන් (85μ) වලින් ද, ස්වර දෙකකින් ද අඩු ඝනත්වයේ පොලිඑතිලීන් (60μ) වලින් ද, අධිඝනත්වයේ පොලිඑතිලීන් (40μ) වලින් ද, පොලිප්‍රොපලීන් (50μ) වලින් ද, අඩු ඝනත්වයේ පොලිඑතිලීන් (75μ) මත ඇලුමිනියම් පටල (10μ) යෙදූ ආකලන ලැමිනේට් සහ පොලිඑස්ටර් (12μ) ඇලුමිනියම් පටල (10μ) සහ පොලිඑතිලීන් (60μ) වලින් තැනූ ත්‍රිස්ථර ලැමිනේට් පටලවලින් ද සෑදූ සෙ.මී. 10×සෙ.මී. 5 ප්‍රමාණයේ මලුවල ඇසුරුම් කරන ලදී. එම මළු 33%, 70%, 80%, 100% යන සාපේක්ෂ ආර්ද්‍රතාවයන්හි සහ පරිසර ආර්ද්‍රතාවයේ ගබඩා කර තබන ලදී. දින 90 ක් ගත වන තෙක් දින පහෙන් පහට මලුවල බරෙහි වෙනස් වීම් තක්සේරු කරන ලදී.

සාපේක්ෂ ආර්ද්‍රතාව 33% දී මළුවල බරෙහි අඩුවීමක් දක්නට ලැබිණ. අනෙකුත් සියළුම සාපේක්ෂ ආර්ද්‍රතාවයන්හි දී බරෙහි වැඩි වීමක් දැක්වුණි. පරීක්ෂණයට භාජනය කළ ඇසුරුම් ද්‍රව්‍ය අතුරින් ලැමිනේට් ද්‍රව්‍ය තෙතමනය කාන්දු වීමට වඩා හොඳ ප්‍රතිරෝධයක් දක්වන බව පෙනිණ. එවැන් ම සතුටුදායක වූයේ ද්විත්ව ලැමිනේට් ද්‍රව්‍ය යි. 80% ට අඩු සාපේක්ෂ ආර්ද්‍රතාවන්හිදී සහ පරිසරයේ සාපේක්ෂ ආර්ද්‍රතාවයේදී ලැමිනේට් ද්‍රව්‍යවල ඇසිරූ කපාපු පොල් 3.5% අවධි මට්ටමට පත් වීමට තරම් තෙතමනය අධිශෝෂණය නොවීය. 100% සාපේක්ෂ ආර්ද්‍රතාවේදී වුව ද ලැමිනේට් ද්‍රව්‍යවල ඇසුරූ කපාපු පොල්වල තෙතමනය අවධි මට්ටමට පත් වූයේ දින 83 කට පසු ව ය. අනෙකුත් ඇසුරුම් ද්‍රව්‍යවලින් ඒ සඳහා ගත වූයේ දින 6 ක් පමණකි. කපාපු පොල් ඇලුමිනියම්/පොලිතීන් ද්විත්ව ලැමිනේට් ද්‍රව්‍යවල ඇසිරීම සුදුසු යැයි නිර්දේශ කෙරේ.

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**අතරැසි ජල අණුවලින් සක්‍රිය වූ කියුප්‍රික්ලෝරෝ සයනයිඩ්වල ඉලෙක්ට්‍රෝනික පරිවහනය**

කේ. තෙන්නකෝන්

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කියුප්‍රික්ලෝරෝසයනයිඩ්වල සංගත සහ මුක්ත අතරැසි ජල අනුවලින් විවිධ සක්‍රියන ශක්තීන්ගෙන් යුත් ඉලෙක්ට්‍රොනික සංන්නායකතා සංකොචනය වන බව පෙනී ගොස් ඇත. මෙම නිරීක්ෂණ පැහැදිලි කිරීම සඳහා න්‍යායාත්මක තර්ක ඉදිරිපත් කෙරේ.

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**කොළඹ දිස්ත්‍රික්කයේ කුඩා කිරිපට්ටිවල අනුගමනය කෙරෙන ස්වන ප්‍රදාහ මර්දන රැඩ සටහනක් අඟැයීම**

යූ. පී. ජේ. එස්. වික්‍රමසූරිය, බී.වී.එස්සී. (ලංකා) එෆ්. ආර්. වී. සී. (ස්විට්.)

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ස්වන ප්‍රදාහය මර්දනය කිරීමේ මෙම රැඩ සටහනෙහි දී, ගොවීනට කිරි දෙවීමේ නිවැරදි ක්‍රම පිළිබඳවත්, කිරි දෙවීමේ දී සනීපාරක්ෂාව පිළිබඳවත් උපදෙස් දෙනු ලැබේ. සියළු ම කිරි දෙනුන් වෙන් වෙන් ව ගෙන කැලිෆෝනියා (ස්වන ප්‍රදාහ) පරීක්ෂණය (සී.එම්.ටී.) මගින් පරීක්ෂා කර එම සතුන් කිරි දෙවීමේ නිවැරදි අනුපිළිවෙලට අනුව සිටුවන ලදී. පළමු පරීක්ෂණ වට දෙකෙහි දී සියළු ම අතුරු සායනික සහ සායනික ස්වන ප්‍රදාහ රෝගයනට ප්‍රතිකාර්ම කරන ලදී. සියළුම සායනික රෝගයනට රැඩසටහන මුළුල්ලේ ම ප්‍රතිකාර්ම කරන ලදී. තනපුවු ගිල්වන ද්‍රව්‍යයක් පාවිච්චි කෙරිණ. කිරි පිදි යන කිරිදෙනුන් සියල්ල ප්‍රතිජෛවක ආවිලනයකින් ආවිලනය කරන ලදී.

නාරාහේන්පිට ජාතික කිරි මණ්ඩලයට කිරි සපයන කුඩා කිරිපට්ටි අතුරින් අහඹු ලෙසින් තෝරා ගත් කිරි පට්ටි 10 ක දෙනුන් 30.7% කත් තනපුවු 14.1% කත් ස්වන ප්‍රදාහ තත්වය තිබිණ. මර්ධන රැඩ සටහන වසර එකහමාරක කාලයක් කරගෙන යාමෙන් ස්වන ප්‍රදාහ තත්ත්වය කිරිදෙනුන්, 13.1 ටත් තනපුවු 5.2% ටත් අඩු විය. රැඩ සටහන අවසාන වන විට දෙනුන්ගේ ස්වන ප්‍රදාහය මුලින් රැඩ සටහන ආරම්භයේ දී පැවති මට්ටමේ සිට කිරි දෙනුන් 57.3% කින් ද තනපුවු 63.1% කින්ද අඩු විය.

එක් එක් ගොවිපල ඒකකයට වැඩ සටහන සඳහා දැරීමට සිදු වූයේ සාධාරණ වියදමකි. ඉන් අත්වන ඇස්තමේන්තු කළ ප්‍රතිලාභ වැව සටහනෙහි වාර්ෂික වියදම මෙන් දෙගුණයකටත් වැඩි විය. එහෙයින් මෙම වැව සටහන සුදුසු යයි නිර්දේශ කරනු ලැබේ.

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**ශ්‍රී ලංකාවේ ඇතැම් පළතුරු සහ පළතුරු නිෂ්පාදනවල යීස්ට් වෙන්කර ගැනීම සහ ලක්ෂණිකරනය**

දලමණී වර්ණසූරිය, ඒ. ඩබ්ලිව්. ලියනගේ, පී. පී. වීරවංශ, පී. කේ. ආතාවුද, සහ පී. එම්. ජයතිස්ස

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ඇතැම් පළතුරු සහ පළතුරු නිෂ්පාදන වලින් වෙන්කර ගත් යීස්ට් වර්ග තිස් හයක් ඒවායේ ජෛව රසායනික සහ රූපවේදිය ලක්ෂණ අනුව හඳුනා ගන්නා ලදී. මෙම යීස්ට් වර්ග ගණ හයකට අයත් විය. එනම් **Candida)** (වර්ග දහසයක්) **Kloekera** (වර්ග නවයක්) **Harseniospora** (වර්ග තුනක්) **Pichia** (වර්ග හතරක්) **Saccharomyces** (වර්ග තුනක්) සහ **Torulopsis** (එක වර්ගයක්) වශයෙනි. එවාත් ම ප්‍රබල ලෙස පැවතුනේ **Candida Krusei** (වර්ග දහයක්) ය.

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**ශ්‍රී ලාංකිකයින්ට වැවෙහි යෙදීමේදී සුව පහසු ඇති ආසනයක සැළසුම් අවශ්‍යතා සහ පරිමාණයන්**

ජේ. ඩී. ඒ. අබේසේකර

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බොහෝ සේවා ස්ථානයන්හි වැවෙහි යෙදීමේ දී සුවපහසුවෙන් තොර ආසන භාවිතා වනු අද බහුලව දක්නට ලැබේ. සුව පහසු ආසනයක වාඩි වී වැවෙහි යෙදීම ශරීරය වීවේකීව තැබීමට ආධාර වන අතර, එමගින් ශක්ති පරිභෝජනය අඩු කෙරෙයි. එහෙත් අනෙක් අතට දිගු වේලාවක් වාඩි වී සිටීමෙන් උදර පේශි බුරුල්වීමත්, පිට කොන්දේ වේදනා ඇති කිරීමටත් ඉඩකඩ ඇත.

ආසනය සැළසුම් කිරීමේ දී නිසි වෛද්‍ය සහ ශ්‍රම විද්‍යාත්මක අදහස් උපයෝගි කර ගැනීමෙන් සුදුසුතම සේවා අසුනක් තනාගත හැකි ය.

සුදුසුතම සේවා අසුනක් ඉදි කිරීමට, එය භාවිතා කරන්නවුන්ගේ ශරීරයේ ප්‍රමාණයන් පිළිබඳ දත්ත රැදගත් වෙයි. මෙම විස්තර, ජාතික මානව මිතික (ශරීරයේ ප්‍රමාණය පිළිබඳ) සමීක්ෂණයකින් ලබා ගැණිනි. මෙම දත්ත පදනම් කරගෙන, වැව අසුනක් සඳහා නිර්දේශ කරන පරිමාණයන් මෙසේ ය.

| | පිරිමි | ගැහැණු |
|---|---|---|
| ආසනයේ උස (පොලවේ සිට) | සෙ.මී. 39.5 | සෙ.මී. 36.4 |
| පිට ඇන්දේ උස (අසුනේ සිට) | සෙ.මී. 44.9 - 46.9 | සෙ.මී. 40.4 - 42.4 |
| පිට ඇන්දේ පළල | සෙ.මී. 37.0 | සෙ.මී. 33.3 |
| | (සෙ. මී. 29.0 අවම) | (සෙ.මී. 25.3 අවම) |
| කට් ආධාරකයේ උස (අසුනේ සිට) | සෙ.මී. 16.4 - 26.5 | සෙ.මී. 16.1 - 25.8 |
| ආසනයේ පළල | සෙ.මී. 39.7 | සෙ.මී. 40.0 |
| | (අවම සෙ.මී. 27.7) | (අවම සෙ.මී. 28.0) |
| ආසනයේ ගැඹුර | සෙ.මී. 36.3 - 41.3 | සෙ.මී. 34.2 - 39.2 |
| අතෙහි උස (අසුනේ සිට) (අත්පුටු සඳහා) | සෙ.මී. 19.8 | සෙ.මී. 18.5 |

වාඩි වුන අයගේ පිටිපස ඉඳිරියට තල්ලු වී නොයන සේ අසුනේ මතුපිට තිරස් අතට 14 - 24° ක් පිටුපසට ඇලවී තිබීම, පිට හේත්තු වන කොටසේ කට්ටි ආධාරකයක් තිබීම සහ අසුනේ පිට 105 - 110° ප්‍රමාණයට හෝ තිරස් අතට 110 - 130° ඇල වූ පිට ඇන්දක් තිබීම අනෙකුත් වැදගත් නිර්දේශයන් වේ.

# இந்த இதழின் கட்டுரைகளின் சுருக்கங்கள்

**1. குடிநீரில் மல அழுக்கிருப்பதற்கு அறிகுறியான பற்றீரியாக் காட்டிகள்பற்றிய ஆய்வு.**

**சந்திரா பி. கொடிகார;**
விலங்கு மருத்துவ, விலங்கு விஞ்ஞான பீடம், பேராதனைப் பல்கலைக்கழகம், பேராதனை, சிறீ லங்கா.

**டீ.எஸ். அத்துரளியா;**
மாநகர விலங்கு மருத்துவ அலுவலகம், கண்டி, சிறீ லங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13** *(1): 1 – 5*

இந்த ஆய்வின் நோக்கம், நீரில் மல அழுக்கு இருப்பதனைக் கண்டுபிடிக்க வழமையாகப் பயன்படுத்தப்படுகின்ற பற்றீரியாக் காட்டி முறைமைகளை ஒப்பு நோக்குதலாகும். இங்கு முக்கியமாக நீரின் பற்றீரியாப் பண்பமைதியினைத் துணிதற் பொருட்டு, கொலிபோம், மலக் கொலிபோம் ஆகிய பற்றீரியாக்கள், மலத்திரெற்ரேக் கொக்கசுக்கள், சல்பைட்டுத் தாழ்த்துகின்ற காற்றின்றிவாழி (குளோத்திரிடியா) வித்திக்கள் சார்ந்த பற்றீரியாக்களுடன் ஒப்பு நோக்கப் பெற்றுள்ளன. கண்டி மாநகரத்து நீர் வழங்கல் முறைமையினின்று எடுக்கப் பெற்ற மொத்தம் 84 நீர் மாதிரிகள் இவ்வாய்வுக்கு உட்படுத்தப்பட்டன. அழுக்கடைந்திருந்த நீர் மாதிரிகளின் நூற்று வீதம் கொலிபோம், மலக்கொலிபோம், மலத்திரெற்ரேக் கொக்கசுக்கள் ஆகிய மூன்று காட்டிகளின் வண்ணம், முறையே 37%, 15%, 54% ஆகவிருந்தது. பண்டுவம் செய்யப் பெற்ற குழாய்நீரின் மல அழுக்கிருப்பதனைத் துணிதற்கு மலத்திரெற்ரேக் கொக்கசுக்களைப் பயன்படுத்துவது இப்பொழுது நடைமுறையிலுள்ள கொலி போம், மலக் கொலிபோம் காட்டி முறைமைகளைவிட அதிகம் அனுகூலமுடைத்தென்பது புலனயிற்று. பெறுபேறுகளின் வண்ணம், நீரின் நலமிக்கப் பண்பமைதியினைத் துணிதற்கு குளோத்திரிடியம் வித்திகளைப் பயன்படுத்துதல் திருப்தியுறும் நிலையில் அமையவில்லை.

**2. ஆண் எலிகளின் கருவளத்தின் மீது சோடியம் மெக்குலோ பெனு மேற்று ஏற்படுத்துகின்ற விளைவு.**

**டபிள்யூ. டீ. ரத்னசூரியா;**
விலங்கியற் பகுதி, கொழும்புப் பல்கலைக் கழகம், கொழும்பு, சிறி லங்கா.

**என்.டீ.டபிள்யூ. லயனல்.**
ஒளடதவியற் பகுதியைச் சேர்ந்திருந்தவர், கொழும்புப் பல்கலைக் கழகம், கொழும்பு, சிறி லங்கா.

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புரோத்தா கிலான்டின் தொகுப்பினைத் தடுக்குமோர் மருந்தாகிய சோடியம் மெக்குலோ பெனுமேற்று 50 % அடங்கப் பெற்ற (3.5 மி.மீ விட்டமும் 10-12மி.மீ. நீளமும் கொண்ட) சிலிக்கோன் றப்பர் கோல் வழியாக எலிகளின் விதைமேற்றிணிவின் மீது நீண்டநாள் வரை பயன்படுத்தப் பெற்றதன் விளைவாக மாற்றமுடியாத கருவளத் தடுப்பு ஏற்பட்டது. இத்தடுப்புக்குப் பின்னர் பாலுணர்ச்சி உந்துகையும் விட்டெறிவாற்றலும் விதை மேற்றிணிவு விந்துவின் நகர்வும் குறைதலுற்றன. விந்துப் புடகங்களின் எடையும் திரளல் சுரப்பிகளின் எடையும் குறைவுற்றன. மேலும் யோனிக் குழாயிலும் விதைப்பையிலும் மெல்லிய அல்லது சுமாரான பிணிமானமும் (கலங்கள் பாதியாக இறந்துபோதல்) ஏற்படுவதும் தென்பட்டது. ஆனால் குறைவான மருந்து அளவினைப் (25 % கோல் அளவு) பயன்படுத்துவதனால் கருவளத்தின் குறிப்பிடத்தக்க மாற்றமோ மேற்கூறிய விரும்பத்தகாத பக்கவிளைவுகளோ ஏற்படவில்லை.

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**3. கொழும்பு மாவட்டத்து சிறிய பால்பண்ணைகளில் மேற்கொண்ட பால்மடியழற்சிக் கட்டுப்பாட்டுத் திட்டம் பற்றிய மதிப்பீடு.**

**யூ.ஜீ.ஜே. எல். விக்கிரமசூரியா, பி.வி.எஸ்.சீ.**
(இலங்கை) எவ்.ஆர்.வீ.சி. (சுவீடன்)
விலங்கு மருந்துவ நூண்ணுயிர்வு நிலையம், வெளிசரை, முகமை, சிறி லங்கா

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(1) 17 – 28

இப்பால்மடியழற்சிக் கட்டுப்பாட்டுத் திட்டத்தின் பொருட்டுக் கமக்காரர்கட்குப் பிழையற்ற பால்கறத்தல் வழிமுறைகள் பற்றியும் பால் கறக்கும் போது கடைப் பிடிக்கப்படவேண்டிய நலவழிமுறைகள் பற்றியும் ஆலோசனை கூறப்பட்டது. கலிப்போனியா பால்மடியழற்சிப் பரீட்சை முறை (க.பா.ப) யின் உதவியைக் கொண்டு பால் மாடுகள் யாவும் தனித்தனியே பரீட்சிக்கப்பட்டன. ஓரளவு பிணியாய்வு தேவைப்பட்ட அல்லது முழுப்பிணியாய்வு தேவைப்பட்ட பால்மடியழற்சியால் பீடிக்கப்பட்ட எல்லாப் பசுக்களுக்கும் முதல் இரண்டு பரீட்சைகளின் போது பண்டுவம் செய்யப்பட்டது. முழுப் பிணியாய்வு தேவைப்பட்ட பசுக்கள்யாவற்றுக்கும் நிகழ்ச்சித் திட்டக்காலத்தில் இடையறாது பண்டுவம் செய்யப் பெற்றது. இதற்கு முலைக்காம்புக் குழியொன்று பயன்படுத்தப்பட்டது. பால் அற்றுப் போன பால் மாடுகளுக்கெல்லாம் பால் இல்லாப் பசுக்களுக்குரிய நுண்ணுயிரெதிரி மருந்து உட்செலுத்தப்பட்டது.

நாரு கேன்பிற்ற, தேசிய பாற் சபைக்குப் பால் வழங்குகின்ற பத்துச் சிறிய பாற்பண்ணைகளில் (இவை எழுமாற்று முறையின் படி தேர்ந்தெடுக்கப் பெற்றவை) கண்டறியப் பெற்ற பால்மடியழற்சி நோய் நிலை கன்று ஈன்ற பசுக்களின் விடயத்தில் 30.7 % ஆகவும் கன்று ஈனுப் பசுக்களின் விடயத்தில் 14.1 % ஆகவும் இருந்தது. இக் கட்டுப்பாட்டுத் திட்டம் ஒன்றரை வருடம் கிடையருது மேற்கொள்ளப்பட்டது. அக்காலப் பகுதியில் கன்று ஈன்ற பசுக்களின் நோய்நிலை 13.1 % வரையும் கன்று ஈனுப் பசுக்களின் நோய்நிலை 5.2. % வரையும் குறைதலுற்றது.

நிகழ்ச்சித்திட்டத்தின் இறுதியில் அத்திட்ட ஆரம்பத்தில் காணப்பெற்ற நிலையின் அடிப்படையில் வைத்து எண்ணப்படுமிடத்து, பால்மடியழற்சி நோய்நிலை கன்று ஈன்ற பசுக்களின் விடயத்தில் 57.3% ஆகவும் கன்று ஈனுப் பசுக்களின் விடயத்தில் 63.1% ஆகவும் குறைவுற்றிருந்தது.

பால் பண்ணை ஒன்றுக்கு ஓராண்டுக்கான மதிப்பிடப் பெற்ற செலவு நியாயமானதாகவே அமைந்திருந்தது. அதனால் பெறப்படும் மதிப்பிடப் பெற்ற நன்மை ஓராண்டுக்கான செலவினத்தின் இரு மடங்குக்கும் மேலாக இருப்பதனால் இத்திட்டம் சிபாரிசு செய்யப்படுதற்கு இயன்றதாகும்.

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**4. எலிகளின் ஊறுநீர் கழிவின் மீது ஏற்படுத்தும் விளைவும் $c^{14}$— கபேன் இழைமப் பரம்பலும்.**

இ.எச். கருணநாயக்கா;
எஸ்.எஸ்.எஸ்.பி.டீ.பி. சொய்சா.
உயிர் இரசாயனப் பகுதி, மருத்துவபீடம், கொழும்புப் பல்கலைக்கழகம், கொழும்பு, சிறிலங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(1) 29 – 44

மலநீர் கழிவின் மீது தேநீர் ஏற்படுத்துகின்ற விளைவும் கபேன் (1 — மெதில் —$c^{14}$) இழைமப் பரம்பலும் நுண் ஆய்வுக்கு உட்படுத்தப்பட்டுள்ளன. ஆண் எலிகளுக்கும் பெண் எலிகளுக்கும் வாய் வழியாக கபேன் (1 - மெதில் — $c^{14}$) ஊட்டப்பட்டதன் பின்னர் முக்கியமாக ஊறுநீர் (சிறுநீர்) வழியாக கதிரியக்கம் (முறையே, அண்ணளவாக 62% உம் 70%உம்) கழிக்கத் தொடங்கியது. 12 - 24 மணிக்காலப்பகுதியில் பெரும்பாலும் இக்கழிவு நிகழ்ந்தது. ஊறுநீரில் சிறிய அளவுகளில் (முறையே அண்ணளவாக 7%உம் 9%உம்) கதிரியக்கம் இருப்பது காணப்பட்டது. ஒப்பீட்டு அடிப்படையில் நோக்குமிடத்து, (1-மெதில் -$c^{14}$ கபேன் வாய் வழியாக தேநீருடன் ஊட்டப் பெற்ற பின்னர் கதிரியக்க ஊறுநீர் கழிவு (அண்ணளவாக 70%உம், 78%உம்) அதிகரிக்கச் செய்தது. பிரதான ஊறுநீர் கழிவு மீண்டும் 12 - 24 மணி நேரத்தில் ஏற்பட்டது.

இழைமப் பரம்பல் ஆய்வுகளில் சில முக்கிய வேறுபாடுகள் தென்பட்டன. தூய்தான கபேன் ஊட்டப்பெற்றதற்கு மாறுக தேநீருடன் கலந்து கபேன் ஊட்டப்பட்டபோது குடல் கதிரியக்கம் வேகமாகக் குறைவுற்றது. ஒப்பீட்டு அடிப்படையில் நோக்குமிடத்து கபேன் தேநீருடன் ஊட்டப்படும்போதெல்லாம் இரத்தத்துக்கான கதிரியக்கப் பண்பு நீண்ட காலம் வரை இடையறாது அதிஉயர் தன் தொழிற்படலுடன் இயங்கலுற்றது. ஆய்வுகள் எல்லாம் அளாவியே நோக்குமிடத்து தேநீரானது கபேனின் இழைமப் பொருள் உள்ளெடுப்பினைக் குறைத்து ஊறுநீர் கழிவு அதிகரிக்குமெனக் கூறலாம்.

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**5. உலர்த்தெங்குத் துகள்களுக்குப் பயன்படுத்தப் பெறுகின்ற பை கட்டும் தாள்களின் ஈரப் பற்றுப் புறத்துறிஞ்சல்**

**யூ. சமரஜீவ; சாமர இளேபெருமா.**
விவசாய இரசாயனப் பகுதி, பேராதனைப் பல்கலைக் கழகம், பேராதனை, சிறி லங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(1) 45 – 52

இலங்கையில் உலர்த் தெங்குத்துகள்கள் 03 சதவீதத்திற்கும் குறைவான ஈரப்பற்று உருவாகும்வரை உலர்த்தப் பெற்று 50 கிலோகிராம் பைகளில் இடப்பெற்று கட்டப்படுகின்றன. இப் பைகள் 85 u கனமுடைய தாழ் அடர்த்திப் பொலிதீன் தாளால் செய்யப் பெற்றவை. இப் பைகளில் உட்பாகம் 5 அடுக்குக் கடதாசிப்படையால் திணிக்கப் பெற்றுள்ளது. இப் பைகள் களஞ்சியத்திடுகையின் போதும் கொண்டு செல்கையின் போதும் உலர்த்தெங்குத் துகள்களால் ஈரப் பற்றுப் புறத்துறிஞ்சில் இடம்பெறும் வகையில் பல மாதங்களாக வெவ்வேறு சார்பு நீர்நயப்பு நிலைகளுக்கு ஆளாகின்றன.

10 கிராம் எடைகொண்ட உலர்த் தெங்குத்துகள்கள் (85 u) தாழ் அடர்த்திப் பொலிதீன் தாள்களைக் கொண்டும் — ஈர அடுக்குத் தாழ் அடர்த்தி (60 u) பொலிதீன் தாள்களைக் கொண்டும் — (40 u) உயர் அடர்த்திப் பொலிதீன் தாள்களைக் கொண்டும் — (50 u) பொலிபிரொபிலீன் தாள்களைக் கொண்டும் — (75 u) தாழ் அடர்த்திப்பொலிதீன் மீதமைந்த ஒட்டல் இயல்புடைய அடுக்குற்ற அலுமினியம் (10 u) மென் தகடுகளைக் கொண்டும் , பொலி யெத்தர் (12 u) / அலுமினியம் மென்தகடு (10 u) / பொலிதைலீன் (60 u) ஆகிய மூன்று அடுக்குற்ற மென்தகடுகளைக் கொண்டும் தயாரிக்கப் பெற்ற 10 செமீ x 5 செமீ அளவு கொண்ட பைகளில் இடப் பெற்றுக் காற்றுப் புகாதவாறு மூடப்பெற்றன. இப் பைகள் 33%, 70%, 80%, 100% ஆகிய சார்பு நீர்நயப்பு நிலைகளிலும் வளிமண்டலச் சார்பு நீர் நயப்பு நிலையிலும் களஞ்சியத்தில் இடப் பெற்றிருந்தன. பைகளில் எடை அதிகரிப்பு 5 நாள் இடை வெளிகளில் 90 நாள்கள் வரை மதிப்பீடு செய்யப்பட்டது.

33% சார்பு நீர்நயப்பு நிலையில் பைகளில் எடை குறைவுறல் கண்டறியப்பட்டது. மற்றெல்லாச் சார்பு நீர்நயப்பு நிலைகளிலும் எடையின் அதிகரிப்பு தென்பட்டது. பரீட்சிக்கப்பெற்ற பொதிகட்டும் பொருள்கள் யாவற்றுள்ளும் அடுக்குற்ற தாள்கள் ஈரப் பற்று அவற்றினூடாகச் செல்வதைத் தடுக்குமாற்றல் பெரிதும் கொண்டிருந்தன. ஈர் அடுக்குத் தாள்களான பைகள் மிகச் சிறந்த ஆற்றல் படைத்தவைகளாக விளங்கின. அடுக்குற்ற தாள்களால் அமைந்த பைகளில் இடப் பெற்றிருந்த உலர்த்தெங்குத் துகள்கள் 80%க்கும் குறைவான சார்பு நீர்நயப்பு நிலைகளிலும் வளி மண்டலச் சார்பு நீர்நயப்பு நிலைகளிலும் 3.5% திரிநிலை மட்டம் அடையும் வகையில் ஈரப்பற்று அதிகரிப்புக்கு ஆளாகவில்லை. அடுக்குத் தாள்களில் இடப் பெற்றிருந்த உலர்த்தெங்குத் துகள்கள் 100% சார்பு நீர்நயப்பு நிலையிலும் திரிநிலை ஈரப்பற்று மட்டம் அடைவதற்கு 83 நாள்கள் சென்ற விடத்து ஏனைய தாள்களில் இடப் பெற்றிருந்தவை 6 நாட்களில் அந் நிலைக்கு ஆளாகியமை குறிப்பிடத்தக்கது. உலர்த் தெங்குத் துகள்கள் ஈரடுக்கு அலுமினியம் / பொலிதீன் தாள்களால் தயாரிக்கப் பெற்ற பைகளில் இடுதல் சாலச் சிறந்ததென விதந்துரை செய்யப்படுகிறது.

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**6. இடைவெளி நீர்மூலக்கூறுகளால் ஏவப்பெற்ற குப்பிறிக்குப் பெரேசயனேட்டில் இலத்திரன் பெயர்ச்சி.**

கே. தென்னகோன்;
பௌதிகவியல் பகுதி, உறுகுணைப் பல்கலைக்கழகம், மாத்தறை சிறி லங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(*1*) *53 – 60*

குப்பிறிக்குப் பெரேசயனேட்டிலுள்ள இணைவுற்ற, சுயாதீன இடைவெளிநீர் மூலக்கூறுகள் பல்வேறு ஏவப்படுத்துகைச் சக்திகளைக் கொண்டு, இலத்திரன் கடத்தலை ஊக்குவிப்பனவென்பது கண்டறியப்பட்டள்ளது. இக்காண்புகளைத் தெளிவாக்குதற்குக் கொள்கைக் காரணவிளக்கம் கொடுக்கப்பட்டுள்ளது.

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**7. கொழும்புப் பிரதேசத்தில் மரணம் சம்பவிக்கின்ற வளர்ப்புப்பறவை நோய்கள், நோய் நிலைமைகள் ஆகியவற்றின் வீழ்தகவு பற்றிய ஆய்வு.**

யூ.ஜீ.ஜே.எஸ். விக்கிரமசூரியா,
பி.வீ.எஸ்சி (இலங்கை), எவ்.ஆர்.வீ.சி. (சுவீடன்), விலங்குமருத்துவ நுண்ணுயிர்வு நிலையம் வெளிசர, சிறி லங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(*1*) *61 – 70*

இக்கட்டுரையில் 1975—1979 காலப் பகுதியில் வெளிசர, விலங்கு மருத்துவ நுண்ணுயிர்வு நிலையம் பதிவு செய்துள்ள கொழும்புப் பிரதேசத்தில் மரணம் சம்பவிக்கின்ற வளர்ப்புப் பறவை நோய்களினதும் நோய்நிலைமைகளினதும் வீழ்தகவு விளக்கப்பட்டுள்ளது. புல்லோரும் நோய், நாட்பட்ட சுவாச நோய், சேவல் தைபொயிட்டு, என்கெபலோமலேசியா, ஆகிய நோய்கள் குறைந்திருப்பது கண்டறியப்பட்டுள்ளது. கொக்கி டியோசிசு, குளிர்நடிக்கம், புழுநோய், நியுமோனியா, குடலழற்சி, கொல் பசிலோசு, உடலகத்துச் சிலேட்டுமசூலை, ஆகிய நோய்நிலைமைகள் குறிப்பிட்ட காலத்தில் மாறி மாறி ஏற்படுவது காணப்பட்டது.

இலிப்போயிட்டு லியுகோகிசு, மரெக்கின் நோய், றனிகெட் நோய், கொப்பூழ் அழற்சி, பரவுகின்ற பீனிசம், பூஞ்சணநோய், உப்புவிடமாதல் ஆகிய நோய்கள் நாளுக்கு நாள் அதிகரித்துக் கொண்டு வந்துள்ளன.

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**8. இலங்கைப் பழங்களினதும் பழத்தயாரிப்புகளினதும் மதுவத் தனிமைப்படுத்துகையும் பண்புருவ வருணனையும்.**

**தில்மனி வர்ணசூரியா; ஏ.டபிள்யூ. லியனகே; ஜீ.ஜீ. வீரவம்சா; பி.கே. அத்தாவுதா; பி.எம். ஜயதிஸ்ஸா.**
(கைத்தொழில் நுண்ணுயிரியல் துறை, இலங்கை விஞ்ஞான, கைத்தொழில் ஆராய்ச்சி நிறுவகம், அஞ்சல் பெட்டி 787, கொழும்பு, சிறிலங்கா.)

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(1) 71 – 75

உயிர் இரசாயனம் மற்றும் வடிவ அமைப்பியல் சார்ந்த சிறப்புப் பண்புக்கூறுகளைப் பயன்படுத்தி, சில பழங்களிலிருந்தும் பழ உற்பத்திகளிலிருந்தும் தனிமைப் படுத்தப் பெற்ற மதுவங்களின் முப்பத்து ஆறு குலவகைகள் அடையாளங் காணப்பட்டுள்ளன. இம் மதுவங்கள் பின்வரும் ஆறு இனங்களைச் சேர்ந்தவை:-
கண்டிடா (பதினாறு குலவகைகள்)
கிளேயோகேரா (ஒன்பது குலவகைகள்)
அன்சேனியோஸ்போரு (மூன்று குலவகைகள்)
பிச்சியா (நான்கு குலவகைகள்)
சச்சரோமை சேசு (இரண்டு குலவகைகள்)
தோறு லாபிசிசு (குலவகை ஒன்று.)
இவ் வினங்களுள் மிக்க ஆதிக்கம் கொண்டது கண்டிடா குறுசெய் (பத்துக் குலவகைகள்) ஆகும்.

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**9. இலங்கையருக்கே வசதிமிக்க வேலை இருக்கையின் வடிவமைப்புத் தேவைகளும் உருவளவைகளும்.**

**ஜே.டீ.ஏ. அபயசேகரா,**
தொழில் நலவியற் பகுதி,
97, சாவத்தை றோட்டு, கொழும்பு, சிறிலங்கா.

*J. Natn. Sci. Coun. Sri Lanka 1985* **13**(1) 77 – 88

இன்று பல தொழில் இடங்களில் வசதிக் குறைவான வேலை இருக்கைகள் பொதுவாகக் காணப்படலாம். வசதிமிக்க இருக்கையில் இருந்து பணி புரிதல் உடம்பு இனிது வைத்துக் கொள்ளவும் சக்தி விரயத்தைக் குறைக்கவும் உதவுகிறது. மறுபுறம் நீண்ட நேரம் உட்கார்ந்துக் கொண்டிருப்பதனால் அடி வயிற்றுத் தசைகள் தளர்வுற்று முதுகு வலியும் ஏற்படலாம்.

வடிவமைப்பு பொருத்தமான மருத்துவக் கோட்பாடுகளின் வண்ணமும் பணிமேலாண்மைக் கருத்துக்களுக்கேற்பவும் தயாரித்துக் கொள்வோமானால் மிக்க நல்லமைதி கொண்ட வேலை இருக்கைகளை உற்பத்தி செய்து கொள்ளலாம்.

மிக்க நல்லமைதி கொண்ட வேலை இருக்கையொன்றைத் திட்டமிடுதற்கு அதனைப் பயன்படுத்துபவர்களின் உடல் அளவைத் தரவுகள் இன்றியமையாதவை. தேசிய மனித அளவை (உடல் அளவைகள்) மேலாய்வு ஒன்றினால் இத் தாரவுகள் வழங்கப்பட்டுள்ளன. அத்தரவுகளின் அடிப்படையில் வேலை இருக்கை ஒன்றுக்கு சிபாரிசு செய்யப்பெற்றுள்ள உருவளவைகள் பின்வருமாறு:

| | ஆண்களுக்கு | பெண்களுக்கு |
|---|---|---|
| இருக்கை உயரம் (தரைமட்டத்திலிருந்து) | 39.5செ.மீ | 36.4செ.மீ |
| பின்புற ஆதாரத்தின் உயரம் (இருக்கையிலிருந்து) | 44.9-46.9செ.மீ | 40.4-42.4செ.மீ |
| பின் புற ஆதாரத்தின் அகலம் | 37.0செ.மீ | 33.3செ.மீ |
| | (ஆகக்குறைய 29.0செ.மீ) | (ஆகக்குறைய 25.3செ.மீ) |
| இருப்பு ஆதாரத்தின் உயரம் (இருக்கையிலிருந்து) | 16.4-26.5செ.மீ | 16.1-25.8செ.மீ |
| இருக்கையின் அகலபிரிவு | 37.7செ.மீ | 40.0செ.மீ |
| | (ஆகக்குறைய 27.7செ.மீ) | (ஆக்ககுறைய 28.0செ.மீ) |
| இருக்கையின் ஆழம் | 36.3-41.3செ.மீ | 34.2-39.2செ.மீ |
| மேற்கை ஆதாரத்தின் உயரம் (இருக்கையிலிருந்து மேற்கையுடைய நாற்காலிகளுக்கு) | 19.8செ.மீ | 18.5செ.மீ |

ஏனைய முக்கியமான சிபாரிசுகள் வருமாறு: மட்டம் முன்னேக்கித் தள்ளுவதைத் தடுப்பதற்குக் கிடைநிலையாக 14-24 பாகம் வரை இருக்கை மேற்புறம்பின்னேக்கிச் சாயச் செய்தல்; பின்புற ஆதாரத்தின் மீது இடுப்புத் தாங்கல் ஒன்று கட்டுதல்; இருக்கையிலிருந்து 105-110 பாகம் வரை அல்லது கிடைநிலையாக 110-130 பாகம் வரை பின்புற ஆதாரம் சாயச் செய்தல்.

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