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Territorial hospitals in the Island Groups are now better equipped. The newest medicines are reaching the dispensaries of the most remote islands. Even so, the local flora which has always provided the islanders with the medicinal plants they required, should not be disregarded, especially when it provides an effective and cheap pharmacopia. The South Pacific Commission proposes to publish a treatise on the medicinal plants of French Polynesia, and a Technical Meeting on the subject will be held in 1973. Specialists from metropolitan countries and major chemist laboratories are interested, but so are the islanders who often have recourse to their local "medicine men" before consulting, when necessary, physicians who practise western medicine. However, a number of those recognize the value of local plants and do not hesitate to make use of them.

Medical services in the island groups, sometimes, run out of medicines. Either stocks have been depleted due to an epidemic or the supply ship has been delayed by a break-down or has run aground on a reef! Furthermore, what would happen if another war were to cut us off temporarily from the metropolitan countries, as happened thirty years ago?

Coconut water, as a natural parenteral fluid, has been used in the South Pacific by Dr HICKING, at present Deputy Director of Health Services of the Trust Territory of the Pacific Islands (Saipan-Marianas) and by Dr ETCHEPARE, Medical Officer of the Tuamotu-Gambier Islands (French Polynesia). A summary of their observations is attached, as it was felt that they could in an emergency be useful to colleagues or to nurses isolated in remote islands.

It is interesting that with no prior information, physicians from different parts of the world have resorted to the same course of action in similar circumstances and geographical conditions.

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COCONUT WATER AS AN EMERGENCY PARENTERAL FLUID

by

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A paper on "COCONUT WATER: its potential as a natural parenteral fluid" was read by Dr HICKING, then Medical Officer in Yap (Caroline Islands) at the Tenth South Pacific Congress held in Honolulu in 1961. In his very exhaustive study, the author (after reviewing medical literature on the subject, which will not be gone into here) describes the physical, chemical, biological and physiological features of this fluid. Later, Mme ANDRIANJATOVO-RARISOA and research workers of the Stomatology Centre of Tananarive Hospital, continued this research; and it is intended in this circular to bring available information up to date.

I The first practical details to be considered are of three kinds: selection and picking of the nuts, their storage, and possibly techniques for bottling the liquid.

I - a It is important, when picking the nuts, to select only seven month old nuts which must be intact, with no cracks. It is only at this particular stage of development of the nut - 7 months - that the water is suitable for intravenous drip infusion: too young it lacks sugar and other constituants; not only is it ineffective but it can be dangerous. At a later stage of development of the nut, the water is too rich in proteins and in fats and could cause serious harm through shock during drip infusion.

The shell of the nut must be intact; coconut water is naturally aseptic only if the shell is uncracked; underground water goes through a process of absolute natural purification during its long journey through the coconut plantation sandy soil, through the very tight successive layers of the coconut palm trunk, a highly efficient filter, and is fully aseptic when it reaches the embryonary sack of the coconut. For the water to remain naturally aseptic the thick, resistant, fibrous, double shell must not be cracked. For this reason the nuts selected must not fall on the ground during picking nor be violently knocked about during transport. A careful examination must be made for the slightest crack and even any possible disease of the nut itself must be detected.

I - b Preservation of the fruit is somewhat tricky if they are to be used far from the place of harvesting or be stored. The water of a freshly picked coconut is always cool whatever the ambient temperature because of its thick insulating fibrous husk. Hours after harvesting, in very hot weather, the water heats up gradually and becomes tepid even if the shell and husk are intact. This gradual heating in a enclosed space, if it lasts too long, can cause fermentation of the sugars and fats contained in the water and the meat. The nuts must therefore be stored in a room whose temperature is not higher than 18 to 20°C or in a refrigerator set at that temperature; 18°C is approximately the usual natural temperature of coconut water in its shell at the time of picking. Too low a temperature maintained for too long, however, could alter the molecular state of the water and of the various elements.

I - c During its use (or its bottling), opening of the shell, handling, decanting of the water, a strictly surgical aseptic state must of course be ensured.

A few practical suggestions may be useful. The strict physico-chemical criteria required of an intravenous drip infusion fluid could be met by having coconut plantations earmarked for medical use, where the bunches of nuts would be labelled and dated at the beginning of development of the nuts so that they could be harvested exactly seven months after this, which is the time when the nuts best meet the requirements.

Moreover, before cutting the enormous stalk of the selected bunch, its stage of development should be checked on a sample, using as a basis the approximate weight of the fruit (3 to 4 kg at seven months) and the quantity of water in the central cavity; the quantity of water in the nut decreases from eight months onwards and the partial vacuity of the cavity of the nut when it reaches maturity can be detected from a distinctive flopping noise made by the water. Lastly the sample nut should be opened, and the thickness and appearance of the meat should be checked as they are very reliable indicators of the stage of development. Only when these checks have been made on a sample should the bunch be selected for harvesting, since all the nuts of a bunch mature uniformally.

Picking precludes the nuts falling on the ground (and therefore possible cracks in the shell).

If there are marked wrinkles at the inferior pole of the nut, it can be discarded as too old, for these are a sign of gradual dehydration of the shell which occurs from about the eighth month.

Nuts should be left attached to the stalk and handled with care during transport to ensure the water remains aseptic inside the nut; they should be stored at the temperatures given above.

II - Chemical composition. Coconut water forms at the beginning of the development of the fruit and fills the embryonary sack which gradually increases in size and becomes a central cavity. In the young fruit, the water is at a pressure of 5 atmospheres and literally spurts out when the internal shell is opened. This pressure diminishes as the nut becomes older and from the ninth month onwards there is no spurting of the liquid upon opening of the nut. These nuts can be discarded, since the water cannot be used for intravenous therapy, and there is no need to check the age of the fruit; furthermore it may be due to a crack in the husk which caused the liquid to escape and therefore a reduction of pressure.

Many research workers have studied the chemical composition of coconut water, but the first two to undertake this research were VAN SLYKE in 1891 on nuts from CUBA, then STEEL in 1922 on nuts from FIJI: both found approximately 3.47 to 4.58% sugar, glucose predominating before maturity, and sucrose (cane-sugar) after maturity.

II - a Glucids. Amongst researchers in this field are CHILD and NATHANAEL in Ceylon. All the nuts of one bunch have an identical content of glucids which increases gradually up to the seventh month, when the maximal concentration is reached, and "cane-sugar" begins to appear; it is at that time also that the quantity of water is highest (500 to 600 cc). The reducing sugars at seven months are glucose and fructose which are products of levulose (whereas EISEMAN detected the presence of Inulin, a polymer of fructose and NATHANAEL that of Mannitol).

As the nut ripens, the toral concentration of sugars diminishes and that of non-reducing sugars increases. At maturity (12 to 13 months) sugars fall to about 2%, of which half are non-reducing sugars (sucrose).

II - b Proteins and amino-acids. At seven months the protein content is 0.02 to 0.43% (multiplied by coefficient 6.25 for the amount of nitrogen ("nitrogen protein"); these percentages are higher if the liquid is not filtered. According to PRADERA there are no large protein complex molecules, this plays a major part in forestalling anaphylactic shock during the drip infusion.

PRADERA detected 12 amino-acids at percentages higher than those of cow's milk in particular arginine, alanin, cystine, serine; and others such as lysine, methionine, valine, leucine, tryptophan, phenylalanine, histidine, considered nowadays as vital, so that coconut water is not merely an electrolyte medium, as it was thought in the past, but actually a nutritive fluid.

II - c Lipids. Up to the seventh month the nut contains between 0.08 to 0.11% lipids when freshly picked, but, the content increases later.

II - d Sodium chloride. GANGULI has given the quantity of sodium chloride as 0.25 to 0.38 gr % depending on age.

II - e Mineral salts. Coconut water contains sodium, potassium, magnesium, calcium, chlorine, phosphorus, sulphates up to seven months. These electrolytes differ little from the composition of the intracellular fluid, but do differ from those of plasma:

Na+, % lower than that of serum

K +, % higher than that of serum, quite high and therefore useful in infantile diarrhoea, but it must be used with care on patients with kidney disorders.

II - f Vitamins. Seven month old coconut water contains a negligible amount of vitamins:

Vit. B : low quantities

Vit. B2: (Riboflavin) in quite large quantities in the ripe nuts (but they must not be used for intravenous drip infusion)

Vit. C : 2.5 mgr to 3.7 mgr % in the immature nuts (7 months) then 2.5 mgr in the older nuts.
It is interesting to note the similarity between the contents of reducing sugars and ascorbic acid (increase then decrease).

III - Physical Characteristics (7 month old nut)

Colour	:	transparent, cristalline, becomes cloudy when heated
Temperature	:	1^{o} below ambient temperature
Density	:	1.015 to 1.031 increasing with age
Viscosity	:	1.180
Cryoscopic point	:	0.652^{o} centigrade
pH.	:	4.8 to 6.4, increasing with age
Surface tension	:	48.06 dynes/cm
Quantity of water:		230 to 750 cc. depending on the variety of nut

IV - Physiological Considerations

All authors who have studied coconut water agree that it has physico-chemical properties comparable to those of human plasma, and EISEMAN considers that because of its content of electrolytes it is a fluid almost similar to intracellular fluid.

However, before it is used as a parenteral fluid, certain precautions are necessary.

IV - a Sterility and pyrogenicity. From VAN SLYKE we know that the water of an intact coconut is absolutely sterile, as mentioned in a preceding chapter, but as soon as it is placed in contact with aerobic and anaerobic bacteria, it becomes an excellent culture medium.

IV - b Isotonicity. Human or animal red corpuscles are not hemolysed by coconut water which is isotonic.

IV - c Antigenicity. Since it contains animal proteins, some antigenic reaction might be expected. But the sensibilisation tests conducted by Pradera, Eiseman and Pinto gave no cutaneous or systematic reactions nor are there any from sub-cutaneous or intravenous drip infusions on man. It would seem that coconut water does not contain any large protein molecules likely to cause an anaphylactic shock.

IV - d Antibodies precipitation test. Eiseman's tests on 8 rabbits during 12 weeks showed no modification of precipitation rates; the highest was 1 : 128.

V - Laboratory tests

Results of all tests, carried out on animals injected with coconut water intravenously, show that there is no specific reaction when precautions are adhered to. Eiseman however found that:

a - in dogs intravenous drip infusion given too fast (normal rate 6 to 10 cc/minute) caused nausea, though vomiting was rare.

b - an intravenous drip infusion of 400 cc of coconut water which had been kept all night in a cold room and contaminated, caused the death of the animal, on the second day, from septicemia.

VI - Clinical applications

There is now ample medical literature on the use of coconut water as a parenteral fluid and in this Information Circular, only a few cases will be reported.

It seems that the first to use this therapy were PRADERA, FERNANDEZ and CALDERON, in Cuba in 1942 with 12 cases; then BRITO and DREISS in San Salvador in 1943 treated 8 patients (6 cases of nephritis and 2 of atrophic cirrhosis in whom they observed a major increase of diuresis, this is highly significant as we shall see later. Amongst many others were MOJUMBAR in Ceylon in 1950 and EISEMAN in Bangkok in 1952, lastly Mme ANDRIANJATOVO-RARISOA and her team in Tananarive, who until recently had already treated 94 cases with coconut water as a natural parenteral fluid, which in some cases contained penicillin, without causing any precipitation, whatever the dosage.

As previously mentioned, in the South Pacific, Dr HICKING in 1949, in twenty cases of severe dehydration, and Dr ETCHEPARE in 1964, in exceptional circumstances, have used this therapy and we give here a brief summary of Dr ETCHEPARE's observations to show the effectiveness and the inocuity of this treatment:

> " In July 1964, in the remote island of TUBUAI of the Austral islands (French Polynesia) I had a severe case of burns (70% of phlyctenular body surface, 16% of it with eschars). Evacuation was impossible, our supplies of serum were exhausted and there were no prospects of being resupplied before some time. I then recalled having read an article by H.S. GOLDSMITH (Boston) in the British Journal of Surgery dated January 1962, and decided to attempt coconut water intravenous drip infusion to reanimate the patient.
>
> Following as strictly as possible the advice I had read with regard to the age of the nut and the vital importance of fully aseptic conditions, I gave my patient a coconut water intravenous drip infusion at the rate of 3 to 5 litres to give him the rehydration his case required.
>
> On the 3rd day the initial state of shock had subsided and his diuresis remained virtually normal, with a slight drop about the 16th day; then became abundant from the 19th day and stable at approximatly 4 litres for 24 hours: the critical phase of kidney blockage with fatal anuria was therefore over and it is this which seemed to me exceptional at the time and which later I compared with the work of BRITO and DREISS.

As soon as he was able to eat, animal proteins only were given, in very large quantities (raw fish with lemon juice, eggs and milk.

The frequency of infusions was gradually reduced between the 28th and 32nd day after the accident and replaced by oral administration of coconut water supplemented by a more varied diet, still rich in proteins, but easily digestible.

As weeks went by the patient improved, his wounds healed gradually, almost without keloids (serum dressings only) and there was no retraction because he was given early and continued mecanotherapy. Having gone slowly through the various stages of recovery, the patient was able to take his first walk, alone, one year after his accident. Then on the 14th month, for his total recovery, I decided to apply skin transplants on the inner part of his thighs (on what was left of the escharoids), which I did not want to do before because of the extremely small surfaces of healthy skin.

I left the island group soon after, but returned in February 1967. I found that this severe case of burns, who had been treated with coconut water intravenously, was back at work completely cured and ... father of a lively little girl!

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Coconut water has been studied extensively by researchers, it has been experimented with more recently by biologists and lastly used as a parenteral fluid with proper precautions, without accident, by physicians but only as a "life-saving therapy" when conventional reanimation was impossible.

Now, the work and decisive observations of Mme ANDRIANJATOVO-RARISOA's team, the successful and unquestionable beneficial effects this water has on the human body: i.e. rehydration in infantile toxicosis, increased diuresis (observation the local "medicine men" know well), and the possible economic impact of this therapy (the trivial cost of the nut) could one day lead to this therapy being accepted as current medical practice, especially in the tropics where the supply and storage of medicines can be difficult.

In any event, this therapy could provide physicians and nurses "in difficulty" with a new life-saving technique and also focus attention on the medical value of the local flora, value the SPC proposes to assess at a Technical Meeting to be held in French Polynesia in 1973.

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