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NEW METHOD IN IODINE TECHNOLOGY

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ABSTRACT

A single bottle with dropper is introduced to contain concentrated KIO_3 solution. The concentrated KIO_3 can be used for many purposes for iodine applications and can be prepared by sub-district health officers, teachers and village health volunteers to give 1,000 μg iodine per drop. For drinking water, two drops are added to a 10 ℓ jar to give 20 μg/100 ml. The dose may be adjusted proportionately for bigger jars. Two versions of iodinators are proposed for secondary schools or places where central or pipe water supply is available. Iodination of well water may be made possible by simple mechanical means. For salt, spray-mixing machines, central and compact types, are made available with low cost but high capacity to salt production centres, junction cities and various provinces. At district level, manual methods can be applied by a spray-mixing table or simply by a small spraying bottle and a plastic sheet. For fish sauce, six drops of the concentrated KIO_3 are added to each bottle of 750 ml in capacity. Double fortification is possible. Concomitantly, as twin bottles with droppers, iodine detection kits are developed for on-sight testing of iodine level in salt and water. The prepared starch KI and acid in each of the two bottles are applied one drop each for qualitative as well as semi-quantitative determination of iodine concentration in water and salt in the villages.

บทคัดย่อ

การเสริมไอโอดีนวิธีใหม่ใช้**ขวดเดี่ยว** ซึ่งเป็นขวดพลาสติกที่มีจุกยางสำหรับหยดสารละลายโพแทสเซียมไอโอเดทเข้มข้น สารละลายนี้อาจเตรียมได้เองโดยเจ้าหน้าที่สาธารณสุขระดับตำบล ครูหรืออาสาสมัครหมู่บ้าน สารละลายไอโอเดทเข้มข้นจากขวดเดี่ยวนี้ ให้ไอโอดีนหยดละ 1,000 ไมโครกรัม ใช้ประโยชน์ได้หลายประการ คือ ใช้หยดลงในน้ำดื่มอัตราส่วนสองหยดต่อน้ำ 10 ล. ได้ความเข้มข้น 20 ไมโครกรัมต่อ 100 มล. ถ้าปริมาณน้ำมากเช่นน้ำในตุ่มใหญ่ ๆ ก็เพิ่มจำนวนหยดของน้ำยาเข้มข้นตามส่วน สำหรับโรงเรียนขนาดใหญ่ หรือบริเวณที่มีท่อประปาหมู่บ้าน อาจใช้ไอโอดิเนเตอร์ หรือท่อปล่อยไอโอดีนอย่างช้า ๆ ได้ ในบ่อน้ำของหมู่บ้าน อาจเสริมไอโอดีนได้โดยวิธีใช้ขวดหลายใบใส่ซ้อนกันแล้วเจาะรูให้ละลายไอโอเดทออกอย่างช้า ๆ สำหรับการเสริมไอโอดีนในเกลืออาจใช้พ่นด้วยเครื่องขนาดใหญ่ หรือเครื่องขนาดกะทัดรัด ซึ่งทำขึ้นเองในราคาถูก แต่มีประสิทธิภาพสูง ใช้ในจังหวัดที่ผลิตเกลือ จังหวัดชุมทาง หรือกระจายไปในระดับอำเภอ ตำบล ลงมาถึงหมู่บ้าน ซึ่งอาจผสมไอโอดีน โดยใช้โต๊ะผสมไอโอดีนด้วยมือ หรือใช้ขวดพ่นกับผ้าพลาสติก ส่วนน้ำปลาก็ใช้น้ำยาเข้มข้นจากขวดเดี่ยวนี้ หกหยดต่อหนึ่งขวด และอาจเสริมเหล็กควบด้วยก็ได้ นอกจากนี้ยังใช้**ขวดคู่**ที่มีจุกยางสำหรับหยดเช่นกัน โดยขวดหนึ่งบรรจุน้ำกรดเจือจาง และอีกขวดหนึ่งใส่น้ำแป้งผสมโพแทสเซียมไอโอไดด์ ใช้หยดลงในน้ำหรือเกลือที่ต้องการตรวจอย่างละหยดเพื่อตรวจไอโอดีนและหาความเข้มข้นโดยใช้ชุดรู้ผลทันที

INTRODUCTION

This article may be entitled as "Ordinary Methods in Iodine Technology." Because of its ordinariness, strongly supported by social mobilization and Iodine Deficiency Disorders (IDD) education, people can do and use it. For continuity, it cannot depend solely on salt; water is to be included at all times at least while waiting for salt. Although salt is the ultimate goal but water is itself an IDD education tool because it requires teaching demonstrations. Therefore both water and salt have to be focused[1, 10, 11, 12] The authors present the iodination technology and applications of both.

MATERIALS AND METHODS

A. Iodization techniques

Preparation for concentrated iodate solution

Single bottle

This is a single 30 ml plastic bottle for concentrated KIO_3. This solution can be used for many purposes:- for iodine applications, for IDD education and can be prepared by sub-district health officers, teachers and village health volunteers.

Preparation : two capfuls (the cap of standard 60 ml plastic bottles), or 24 g of KIO_3 (14.24 g of iodine) in an aluminium packet, are dissolved in 725 ml of hot boiling water. The volume of 725 ml can be measured by filling a Mae Khong whiskey bottle, widely available in Thailand, up to the lower border of the neck, to give a concentration of 20 mg/ml or 1,000 μg per drop with a dropper producing 20 drops/ml. The prepared KIO_3 solution in the Mae Khong bottle is then used to fill twenty four 30 ml plastic bottles with droppers, and one of these is provided to each family in the village and to school teachers.

Applications to drinking water and salt

Water

Small jar : two drops of the prepared KIO_3 solution are added to a 10 ℓ jar and mixed thoroughly with a wooden dipper (Figure 1). This iodated water containing 200 μg iodine ℓ, is prepared and consumed daily by the villagers. For schools, two drops of KIO_3 solution are added to a 10 ℓ water cooler (measured by filling 13 times of the whiskey bottle) giving 20 μg/100 ml. Each student is given 200 ml of the water during lunch. For bigger jars, the concentrated KIO_3 solution required is increased by the number of drops proportionately.

For family members who have to work in the rice field, smaller or junior bottles may be available so that they may take it with them for their own individual use. The farmers may add one drop each in the lunch or in a glass of water as they like. This

junior bottle is very compact and may contain 15 ml with dropper of 25 drops per ml. At 50 μg I per drop, it has approximately 20,000 μg of iodine which requires 20 drops of the concentrated KIO_3 from the single bottle and water is added up to 15 ml.

Iodinator : The authors have also developed a simple iodinator for slow release of KIO_3 into the water[1] or a new one (Figure 2) to add concentrated KIO_3 solution slowly to the flow of water at concentration of 0.1-0.4 ppm throughout the year. The components of the device are simple and the total construction cost was about US $5. The unit may be used in secondary schools where pipe water supplies are available under closed control by the students.

Iodination of well water : Four small plastic bottles each containing 30 g KIO_3 are filled with water. All these bottles are put into a larger plastic bottle (1 ℓ) containing 1:4 sand and water. All bottles are perforated with few holes to produce slow leakage of the concentrated KIO_3. The large bottle fixed by a rope is then dropped to about 50 cm below the surface of the well water. The concentration of KIO_3 in the well water can be adjusted by the number of holes in the outer bottle. The water should be monitored daily during the initial weeks and occasionally later on, to guide adjustment of the KIO_3 concentration. This iodated source may last for several months before refilling.

Salt

Iodation of salt : Spray-mixing machines are used at central levels and in big junction cities like Chiang Mai and Lampang provinces or at the production sites like Chaiyaphum, Maha Sarakham, Sakon Nakhon or Udon Thani provinces. For these centres, the central conveyor type of locally made machines[1] operating at the rate of 8 tons/h with a capacity of 30-50 tons a day is recommended. Its construction costs about US$ 2,000. Smaller units, the compact rotary type of spraying machine (Figure 3) with a capacity of 5 tons a day can be conveniently used at individual provinces and community districts. The unit may be non-electrical. The major part of the unit is made of wood. It costs only US$ 650.

In groups of villages where labour cost is not a problem or in schools with unpaid labour, a spray mixing table is used. The table houses two large salt-containing basins that can be emptied from the bottoms. Spray bottles are hand-operated at the rate of 50 kg in 10 min or 300 kg/h. For a sub-district of 10 villages, it takes about 20 working days for spraying 18 tons of salt. The construction cost of the table is about US$ 48.

Spraying can also be done manually in the village by the villagers themselves preferably by the village grocery shop, the school or the village co-operative group, run by the village revolving fund. To 24 kg of salt on a plastic sheet, 60 ml of concentrated KIO_3 diluted to 240 ml in a spraying bottle may be spray-mixed by hand. The iodated salt was divided into small polyethylene bags that were then heat-sealed by candle flame. The set costs about US$ 4.

Fish sauce

Fish sauce which is widely used in Thailand, can be mixed with six drops of the concentrated KIO_3 for each bottle or can be pre-mixed at the local fish sauce bottling factory. Fish sauce production may be economically developed aiming at improving taste, smell but cheaper price by specially prepared flavor-ing agents. The cost will be within the purchasing power and the acceptability of the fish sauce by the local consumers is extremely high. The double fortification with ferric sodium EDTA is possible, providing good bio-availability of iron[2, 3, 9].

B. Iodine detection kits

Preparation of starch and acid[4, 5]

Twin bottles

Kits for on-sight testing of iodine level in salt and water have been developed. Two 30 ml bottles are used, one containing diluted HCl (solution A) and the other a starch KI solution (solution B). For solution A, 180 ml of concentrated (12N) HCl are measured by filling a 60 ml bottle three times then diluting to 725 ml with water in a Mae Khong bottle, adding the acid gradually to prevent spurting, and filling up the bottle with water to the level of the lower border of the neck, to make a 3N solution. This must be prepared away from the children in the district hospital or at the health post or the so called "the village iodine centre" run by the village grocery shop. For the second bottle (solution B) two capfuls (the top of a Mae Khong bottle) of tapioca flour (2×8 g) are dissolved in 10 ml of water in a Mae Khong bottle. Boiling water is added to the level of the bottle shoulder and left until it cools. Two capfuls of KI (2×21.6 g) are then added, followed by 15 ml of 10% sodium azide as preservative, and the bottle is then filled with water to the lower border of its neck. From this stock solution, 24×30 ml plastic bottles are filled with either solution A or B. Then a bottle of solution A is taped to one of solution B or put into a card board box with instructions and colour scale for quantitation over the box. These serve as instant kits for detecting and estimating the concentration of iodine in water and salt. These kits are provided in quantities for use in villages, schools, district hospitals, and health posts.

Applications to detect iodine in water and salt

Testing water : To test the iodine content of water, a drop each from solution A and B is added to 5 ml of water. If the iodine concentration is at least 0.2 ppm, a faint blue colour is produced. The colour developed can be compared with that of standard and the concentration of KIO_3 appropriately adjusted.

Monitoring salt : To test iodate in salt, a drop of solution A is added to about one-half teaspoon of salt, followed by a drop of solution B (Figure 4). If the salt is adequately iodated, a deep blue-black colour will immediately appear. If non-iodated, there will be only an immediate faint bluish colour and deeper colour on delayed obser-

vation. The amount of iodine in any sample of salt can be determined by comparison with a standard sample containing 1:20,000 parts iodine. Two capfuls (cap of 30 cc plastic bottle) or about 4 g of salt sample are dissolved in a Mae Khong bottle. A similar amount of the standard(iodated) salt sample is dissolved in another Mae Khong bottle. The colour development between the standard and sample can be compared and the concentration of the sample adjusted.

Both solutions for the concentrated KIO_3 and for detection kit are prepared at district or community hospitals. The community hospitals, as focal points for peripheral control of IDD, co-operate with the central administrative body and the network stations to transmit educational packages and the necessary materials for IDD control to the periphery.

DISCUSSION

Although the advantages of the technology for the villages are many but it needs nearly all efforts and investments in training demonstration, the social mobilization, the psycho-social stimulation, logisitics and continued public education **regularly**. As the first step, the iodated water[7,8,9,10,11] may be spread rapidly to sensitize schoolchildren followed by family members in households. The iodated salt may be followed as the ultimate goal[12]. The use of double vehicles with appropriate concentration of iodine may have the re-assuring results of preventing the failure from irregular and inadequate distribution of iodated salt alone. The popularity of the water is clearly demonstrated by villagers' participation and self-support for the cost of dropper bottles. As the measure to push the salt into the village grocery shops, we are promoting decentralized iodization of the salt at provincial level by encouraging the use of compact spraying machines. The profit made by retailing sale of small bags of iodated salt is a good incentive for the locality. The two bottles of detection kit are a very important tool to educate both public and salt dealers. The kit is handy for monitoring and surveillance. It must not be under-used and should be propagated concomitantly with the single bottle of concentrated KIO_3. The number of these bottles utilized in the households and schools may be one of the measuring indices for epidemiological monitorings.

Two pitfalls were found in the preparation of the dropper bottles. The problem is the cross contamination of the concentrated KIO_3 and the starch KI when prepared in the same area. To avoid this, the two iodine solutions should be prepared entirely separately. Another problem is the misplaced Mae Khong bottle of concentrated KIO_3 in the refrigerator. Accidental drinking of the solution may occur unless it is at once divided into 24×30 ml plastic bottles or labeled clearly as such and not for direct drinking. The iodine excess may be taken care of by forced fluid and perhaps potassium perchlorate.

For the social implications, one of the constraints to be met with is the behavioural interactions of the consumers[13]. Some of them become boring with the regular

addition of drops of concentrated KIO_3 into the drinking water. This compliance of the consumers may be gained by a blunt question that are there any parents and teachers who will yield to let their offsprings and students to be retarded among their classmates? Another strategy is to establish at the same timing the iodated salt and its evenly distributed and regular availability. It may depend on water and salt or salt and fish sauce for daily requirement of iodine.

Finally, to create new methods, the misconcept[14] among the general medical and nonmedical circles that goitre is not an urgent problem must be corrected and its importance on educability of children convinced. For the long term projection, the iodine technology with its mobilization is only one of the re-enforced factors. The continuity of the programme needs the enabling factor of recognition of the importance of IDD as priority problem by governmental administration, politicians' decision, the international organizations and other international and national donor agencies. The five year sustaining rate of the programme have been interrupted by the top policy of "Goitre is not a priority problem. It can wait. What we have done is enough". This mistake has been frequently repeated un-necessarily unless the international and domestic working groups will insist that IDD must be eradicated by sustainable actions for at least two coming generations.

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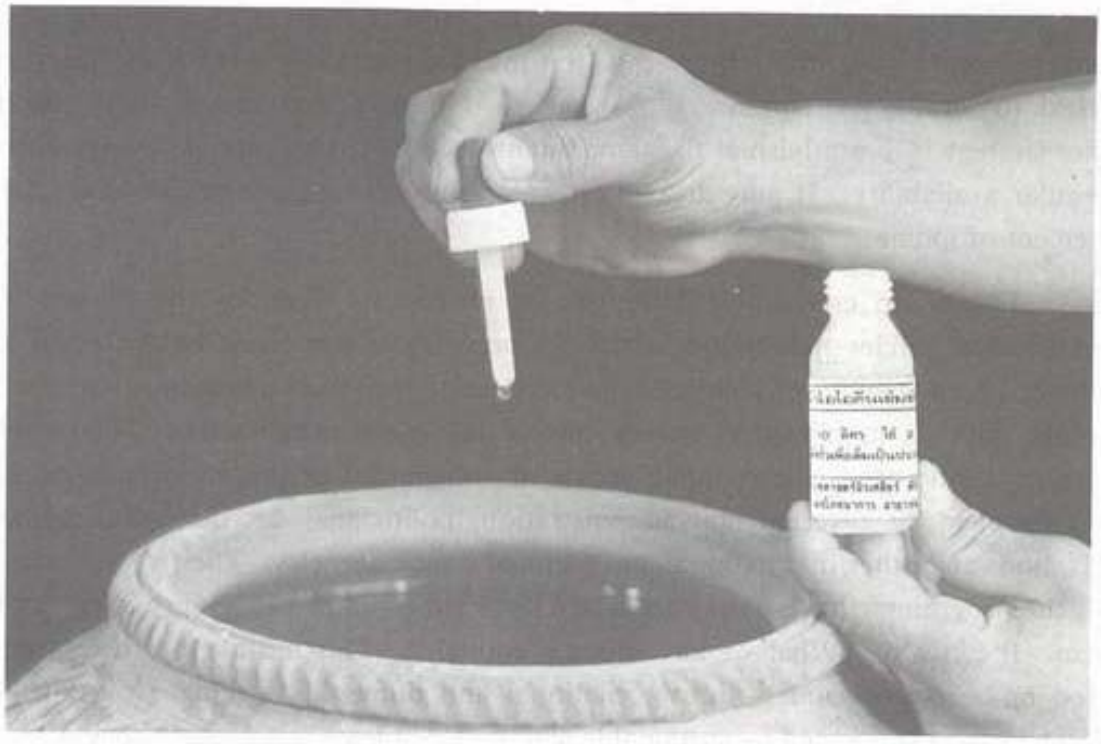

Fig. 1 The single bottle of concentrated KIO_3 solution at 1,000 μg I per drop. Two drops of the solution in 10 *l* of water (13 Mae Khong whiskey bottles) gives a concentration of 200 μgI/*l*.

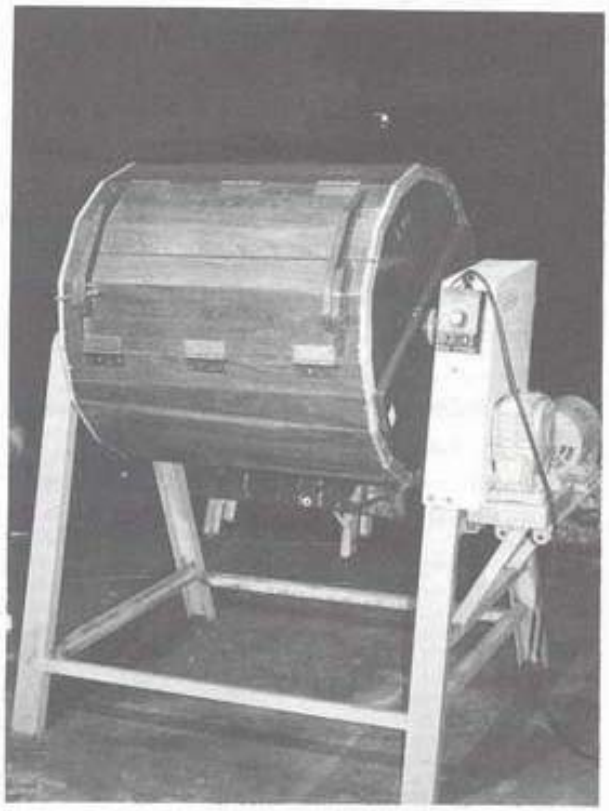

Fig. 2 The compact rotary type of spraying machine with wooden components, containing fishbone wooden structures on the inner wall.

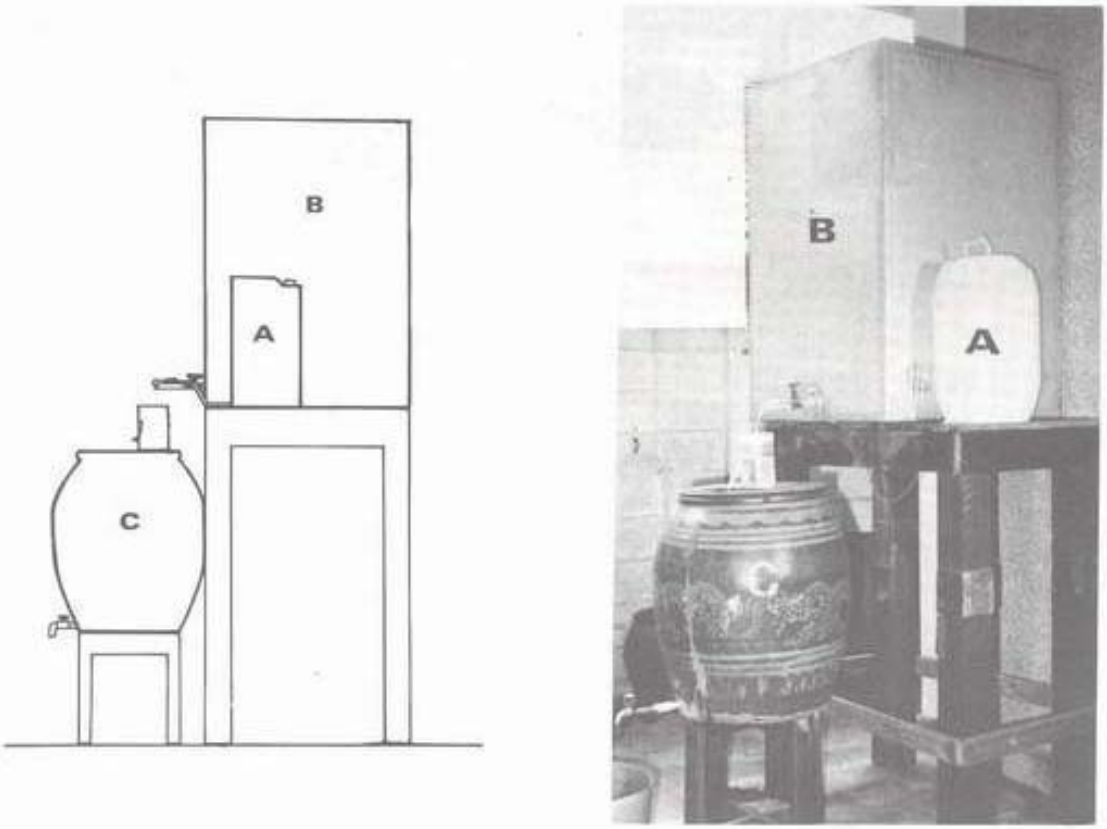

Fig. 3 Simple iodinator. A: conc. KIO_3 solution (24 g in 20 *l* of water) to jar C at 10 drops/min, at the same time as water flow at 5 *l*/min from the reservoir B via calibrated V perforation of the plastic cylinder A.

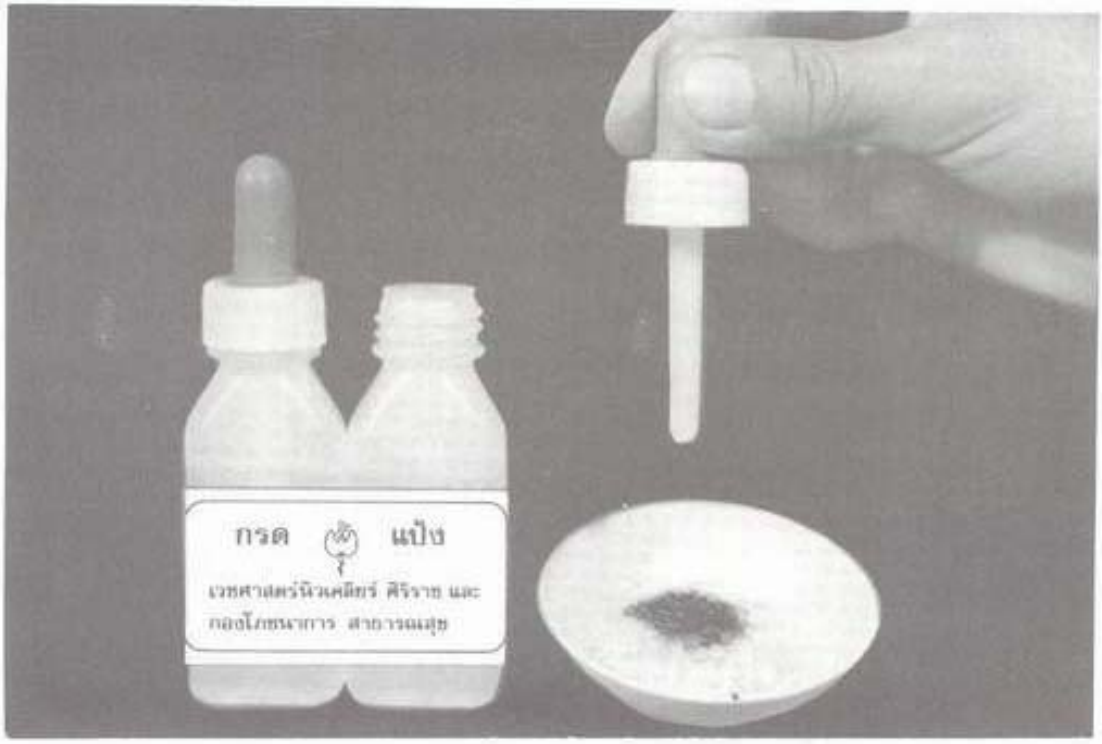

Fig. 4 The twin bottles as an instant kit for iodine detection. Iodine in iodated salt (or water) can be easily monitored *on site* using one drop from each bottle.