

§9. Natural Radiation Sources Fabricated from 12 Brands of Chemical Fertilizers and New Educational Technique

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Many materials on earth contain naturally occurring radioisotopes such as ^{40}K , ^{232}Th , and ^{238}U that release radiation. However, many people do not realize that such naturally occurring radioisotopes exist. Therefore, radiation education is important to improve understanding of the existence of natural radioisotopes and radiation. Chemical fertilizers containing potassium are often used for this purpose in educational courses on radiation. Naturally occurring potassium consists of three isotopes: ^{39}K , ^{40}K , and ^{41}K ; the ^{40}K naturally emits a 1.33-MeV beta particle and a 1.46-MeV gamma ray. In the earlier study, a compression and formation method was developed for fabricating disk-shaped radiation sources from raw materials such as potassium chloride, kelp, chemical fertilizer, and sinter, which contain naturally occurring radioisotopes. In the present study, the compression and formation method was applied to 13 commercially available chemical fertilizers containing different amounts of potassium (Table 1).

Table 1 Ingredient percentages for 13 brands of chemical fertilizers.

Fertilizer brand name	Sackful weight (g)	Contents (%) [*]			Manufacturer or Delivery agent
		N	P	K	
(1) Ryusan-kari	700	0	0	50	Asahi Industries Co., Ltd.
(2) Rinkari-hiryo	700	0	16	15	Hanagokoro Co., Ltd.
(3) Betyunia-sukusuku	1000	3	12	12	Applied Natural Products Co., Ltd.
(4) Yukkuri-nagakukiku-hiryo	1000	10	10	10	GI Co., Ltd.
(5) Yosai	700	12	8	10	Toen Co., Ltd.
(6) Puromikku	350	8	12	10	HypoNex Japan Co., Ltd.
(7) Gurin esu	700	10	10	10	Hotta Syoten Co., Ltd.
(8) Motohi-sodachi-BB	320	6	24	9	Hanagokoro Co., Ltd.
(9) Yasaino-yukikasei	800	8	8	8	Applied Natural Products Co., Ltd.
(10) Tennenryuzyo-rinkari	500	0	21	8	Nisshin Gardenmate Co., Ltd.
(11) Maguamp	250	6	40	6	HypoNex Japan Co., Ltd.
(12) Hananaeno-tsuhi	700	6	9	6	Joy Agris Co., Ltd.
(13) Kyukonno-hiryo	500	3	7	5	Hanagokoro Co., Ltd.

The fabricated disks are natural radiation sources, referred to as chemical fertilizer radiation sources or fertilizer sources. The suitability (size, weight, solidness, and smell) of the 13 fertilizer sources as educational tools for radiation education was examined. Some of results are shown in Table 2 and indicated that all of the fertilizers but one could be used as natural radiation sources. In Table 2, data of “Maguamp” are not listed. This chemical fertilizer was too fragile to fabricate into a disk using the compression and formation method (Fig. 1).

The radiation strength (count rate) and potassium content of the other 12 fertilizers were measured, and the relation between potassium content and radiation count was examined. Figure 2 was the results and showed that a linear relation existed between the radiation count emitted from the fertilizer sources and the percentage of potassium in the chemical fertilizers. This linear relation demonstrates that the count rate corresponds to the percentage of potassium.

Table 2 Disk-shape of respective chemical fertilizer sources.

Fertilizer brand name	Disk-shaped source		
	Weight (g)	Diameter (mm)	Thickness (mm)
(1) Ryusan-kari	19.9	35.3	9.8
(2) Rinkari-hiryo	20.1	35.5	10.8
(3) Betyunia-sukusuku	20.1	35.3	10.1
(4) Yukkuri-nagakukiku-hiryo	20.0	35.3	11.4
(5) Yosai	20.2	35.2	12.1
(6) Puromikku	20.2	35.3	11.0
(7) Gurin esu	20.3	35.2	10.8
(8) Motohi-sodachi-BB	20.1	35.2	11.1
(9) Yasaino-yukikasei	20.2	35.3	11.7
(10) Tennenryuzyo-rinkari	20.1	35.2	8.9
(11) Maguamp	====	====	====
(12) Hananaeno-tsuhi	20.3	35.3	11.7
(13) Kyukonno-hiryo	20.1	35.3	12.3
Average	20.1	35.3	11.0
SD	0.12	0.07	1.0
	(0.6%)	(0.2%)	(8.9%)

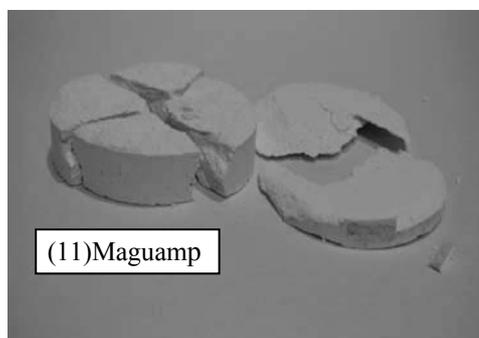


Fig.1 Failure in fabricating chemical fertilizer radiation sources.

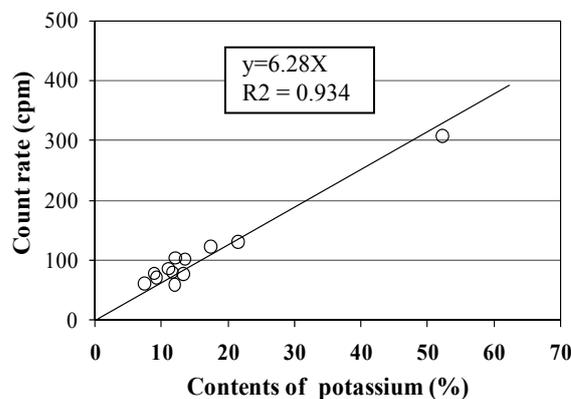


Fig.2 Relationships between count rates and respective ingredients

Therefore, a new educational technique using the fertilizers can demonstrate that the radiation emitted from the fertilizers can be attributed to the potassium contained in the fertilizer sources. However, these results were obtained by compiling all of the data obtained by 12 fertilizer sources; in some cases the relation between radiation count and potassium percentage was inverted. To demonstrate that the substance emitting radiation is potassium, the selection of fertilizer source material is very important.