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Incidence of Parasites Found on Vegetables Collected from Markets and Vegetable Gardens in Taegu Area

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Since the first report of Oda (1927) on the incidence of parasites from vegetables in Korea, the incidence in Seoul areas has been established gradually by additional reports (Chiba, 1928; Chyu, 1957; Choi et al., 1967; Kim et al., 1968; Kwon et al., 1969).

Choi et al. (1967) reviewed his work comparing his findings with the report of Chyu (1957) on the number of parasites attached to vegetables, and observed that there has been no significant reduction in the incidence and intensity of parasites on vegetables since 1957. This is partially interpreted by the fact that Koreans are fond of pickled (Kimchi) and raw vegetables which were cultivated on the farms and fertilized with non-treated night soil.

The high incidence of intestinal parasites among the inhabitants of Kyungpook Province was reported by Choi et al. (1971). However, the parasitic incidence in vegetables is still undetermined.

The purpose of this survey was to determine the incidence of parasites attached to vegetables in the Taegu area and to provide epidemiologic and parasitical information on vegetables.

MATERIALS AND METHODS

Vegetables, which consisted of lettuce(Lactuca sativa), young radish(Raphanus sapivus), and Chinese cabbage (Brassica pekinensis), were collected from the markets and vegetable gardens in the Taegu area. All vegetables were divided into 2 groups, leaves and roots. The roots were excluded from vegetables because Koreans do not make pickled vegetables. After measuring the weight of each vegetable and counting the number of leaves on each vegetable, they were transferred to a Petri-dish with a capacity of 2,000 ml. Then 200 ml of tap water was poured into the dish. Both sides of the leaves were washed carefully with a hard brush, and then removed from the dish.

The results of this survey were presented at the 1972 spring meeting of the Korean Society for Parasitology.

While stirring with a glass probe, the vegetable wash water was transferred, to a sedimentation flask with a capacity of 500 ml. The dishes and brusches were then rinsed twice with 150 ml of tap water. After sitting undisturbed for 10 hours, the supernatant which formed in the flask, was decanded by the use of a loop. Using a funnel, with a layer of iron gauze inserted for straining, the sediment was transferred to a graduated centrifugal tube. The tube was then centrifuged for five minutes at 2,500 rpm's. The supernatant was removed from the tube with a pipette and the sediment was used as a sample.

In order to determine the mean number of parasites per 200 gm of vegetable weight, the total amount of sediment in a graduated centrifuge tube was measured and adjusted to 1 ml adding tap water. Immediately after stirring, the number of eggs and larvae in 0.1 ml of the sediment was counted microscopically.

In order to identify the species of eggs and larvae, 4 to 5 ml of magnesium sulfate solution, with a specific gravity of 1,270, was poured into the centrifuge tube, which was then corked with rubber stopper, shaken, and filled again with the above reagent until a concave liquid surface formed at the top of the tube. The substances which floated to the surface were attached to a coverglass and placed on a slide glass. The substance(larvae) on the slide was examined under a microscope to determine the species of worms.

ENVIRONMENTAL AND CLIMATIC CONDITIONS IN TAEGU

The city of Taegu, with an estimated population of 1,100,000, is located at the mid point of southern part of Korea. The climate in 1971 was hot and relatively humid in summer and cold and dry in winter with a mean daily temperature of 13.2'C and a seasonal variation of −9.6'C to 36.3'C. Heavy rains occured from June until August with the remainder of the year being relatively dry. The average rainfall in 1971 was 60.2 millimeters.

RESULTS

The species of parasitic eggs and larvae found on lettuce leaves selected from 6 markets in Taegu are presented in Table 1. Three hundred leaves of lettuce were examined.

Table 1. Eggs and larvae of parasites found on lettuce leaves collected from markets (1970-71)
Number examined: 50 in each market

Parasite	Markets collected lettuce						Total
	Chil-seong	Bang-cheon	Yeon-mae	Jung-ang	Dong-boo	Seo-moon	
Ascarid egg	24(48.0)	27(54.0)	18(36.0)	26(52.0)	29(58.0)	23(46.0)	147(49.0)
Trichurid egg	3 (6.0)	4 (8.0)	2 (4.0)	1 (2.0)	3 (6.0)	7(14.0)	20 (6.7)
Trichostrongylus egg	11(22.0)	13(26.0)	10(20.0)	8(16.0)	9(18.0)	3 (6.0)	54(18.0)
Clonorchis egg	0	2 (4.0)	0	1 (2.0)	2 (4.0)	0	5 (1.7)
Hookworm egg	10(20.0)	7(14.0)	13(26.0)	11(22.0)	6(12.0)	12(24.0)	59(19.7)
Filariform larva	2 (4.0)	2 (4.0)	0	3 (6.0)	7(14.0)	5(10.0)	19 (6.3)
Rhabditoid larva	0	1	1 (2.0)	0	0	0	2 (0.7)
Egg & larva undetermined	28(56.0)	29(58.0)	26(52.0)	15(30.0)	31(62.0)	16(32.0)	145(48.3)
No parasite	19(38.0)	21(42.0)	17(34.0)	22(44.0)	16(32.0)	18(36.0)	113(37.7)

( ): Percentage.

Five species of intestinal helminth eggs and 2 larvae of hookworms were detected. The incidence of ascarid egg was found to be high (49.0%), followed by Trichostrongylus egg and filariform larva of hookworms (18.0% and 19.7%, respectively). The least frequently observed species was rhabditoid larva of hookworms. In addition, a number of eggs and larvae of nematodes morphological undetermined were also found. There was no significant difference in the incidence of parasites among the six Taegu markets(Table 1).

The recovery rates of parasites among lettuce, young radish, and Chinese cabbage are shown in Table 2. Nine hundred and forty seven vegetables which consisted of 300 lettuces, 512 young radishes, and 137 Chinese cabbages were examined. 247 or 26.3 percent were negative for parasites, the remainder of vegetable had a variety of parasite eggs and larvae. The recovery rate for ascarid egg in

Table 2. Eggs and larvae of parasites found on vegetables collected from markets (1970-71)

Parasite	Vegetables examined			Total
	Lettuce	Young radish	Chinese cabbage	
Ascarid egg	147(49.0)	199(23.2)	124(91.9)	470(49.6)
Trichurid egg	20 (6.7)	41 (8.0)	57(42.2)	118(12.5)
Trichostrongylus egg	54(18.0)	23 (4.5)	35(25.9)	112(11.8)
Clonorchis egg	5 (1.7)	6 (1.2)	9 (6.7)	20 (2.1)
Hookworm egg	59(19.7)	47(9.2)	71(52.6)	177(18.7)
Filariform larva	19 (6.3)	86(16.8)	19(14.1)	124(13.1)
Rhabditoid larva	2 (0.7)	21 (4.1)	13 (9.6)	36 (3.8)
Egg & larva undetermined	145(48.3)	183(35.7)	58(43.0)	386(40.8)
No parastd	113(37.7)	133(26.0)	3 (2.2)	249(26.3)
No. examined	300	512	135	947

( ): Percentage.

Table 3. Eggs and larvae parasites found on vegetables collected from vegetable gardens (1970-71)

Parasite	Vegetables examined			Tatal
	Lettuce	Young radish	Chinese cabbage	
Ascarid egg	109(58.6)	27(21.6)	48(96.0)	184(51.0)
Trichurid egg	17 (9.1)	13(10.4)	16(32.0)	49(12.7)
Trichostrongylus egg	37(19.9)	11 (8.8)	10(20.0)	58(16.1)
Clonorchis egg	5 (2.7)	2 (1.6)	3 (6.0)	10 (2.8)
Hookworm egg	28(15.1)	12 (9.6)	27(54.0)	67(18.6)
Filariform larva	9 (4.8)	28(22.4)	8(16.0)	45(12.5)
Rhabditoid larva	2 (1.1)	7 (5.6)	3 (6.0)	12 (3.3)
Egg & larva undetermined	98(52.7)	54(43.2)	32(64.0)	184(51.0)
No parasite	46(24.7)	23(18.4)	0	69(19.1)
No. examined	186	125	50	361

( ): Percentage.

Table 4. Number of parasite eggs and larvae found in young radish, unwashed and washed at vegetable washing stand

Parasite	Young radish examined		Difference(%)	T-value
	washed	not washed		
Ascarid egg	9(12.3)	18(23.1)	7.3	1.09
Trichostrongylus egg	4 (6.8)	10(12.8)	6.0	1.18
Hookworm egg	3 (5.3)	9(11.5)	6.2	1.32
Filariform larva	5 (8.8)	16(20.5)	11.7	2.00
Rhabditoid larva	0	2 (2.5)	2.5	—
No parasite	8(14.0)	12(15.3)	1.3	0.21
No. examined	57	78		

( ): Percentage.

Table 5. Monthly variation of numbers of parasites found on yong radishes collected from markets and vegetable gardens (July-October, 1971)

Parasite	Month			
	July	August	September	October
Ascarid egg	10(18.5)	74(40.4)	101(47.0)	78(34.7)
Trichostrongylus egg	4 (7.4)	7 (3.8)	3 (1.4)	14 (6.2)
Hookworm egg	9(16.7)	8 (4.4)	13 (6.0)	23(10.2)
Filariform larva	2 (3.7)	47(25.7)	65(30.2)	20 (8.9)
Rhabditoid larva	1 (1.9)	0	4 (1.9)	7 (3.1)
Egg & larva undetermined	5 (9.3)	20(10.9)	51(23.7)	45(20.0)
No parasite	37(68.5)	62(33.9)	23(10.7)	56(24.9)
No. examined	54	183	215	225

each of 3 vegetables ranged from 23.2 to 91.9 percent. The cabbage showed the highest, and lettuce next in positivity(49.0%). A part of these differences is probably due to differences in weights of a vegetables. On the contrary, the rate of filariform larva in young radish showed a relatively high rate (16.8%) compared with that of lettuce and Chinese cabbage. Generally, the recovery rate by the species of vegetable, as presented in Table 2, was significant except in the case of filariform larvae, where the rate in the Chinese cabbage was approximately twice as high as that of lettuce and yong radish.

The rate of parasite eggs and larvae on vegetable leaves collected from markets, as shown in Table 3, was similar to that from vegetable gardens(Table 3). These rates were not analyzed because there were insignificant differences between these two areas.

Table 4 shows a comparison of the recovery rate of parasites found in young unwashed and washed radishes at the vegetable washing stand. There was a considerable reduction in the rates of all parasites as a whole, when young radishes were washed at the stand. Of 57 samples, only 9 showed ascarid eggs. On the other hand, a high rate of the eggs was revealed in

Table 6. Mean numbers of ascarid eggs found per 200 grams in each of lettuce, young radish, and Chinese cabbage (1970-71)

4 categories	Lettuce	Young radish	Chinese cabbage
No. of vegetables examined	752	677	185
Total vegetables weight (gram)	15,752	59,576	530,955
Total number of egg found (each)	245	2,264	1,327
Mean number of egg per 200 gram of vegetable	3.1	7.6	0.5

the case of unwashed samples. Although the difference in ascarid egg was calculated to be 7.3 percent, no significant difference was found between these two young radishes($t=1.09$). However, a significant value was observed in the case of filariform larva ($t=2.0$).

Table 5 shows that in the hookworm eggs and filariform larvae found, there are significant monthly flactuations of parasitic eggs and larvae. The recovery rate for the hookworm egg showed 16.7 percent in July, followed by a abrupt decrease during the period from August until September, and an increase again in October, On the other hand, the recovey rate of filariform larva showed an abrupt increase in August, and then a gradual steady increase each successive month In October, the rate decreased.

A comparison of the mean number of ascarid eggs per 200 grams of vegetable are presented in Table 6. The mean number of ascarid eggs recovered was 7.5 from young radishes, 3.1 from lettuces, and 0.5 from Chinese cabbages, in decreasing order. Generally, the mean number of ascarid eggs in yong radishes was more than 10 times that of the Chinese cabbages.

DISCUSSION

In the infection of parasites in man, a series of parasitical surveys on vegetables may be of considerable importance in epidemiologic considerations. For this reason, the recovery of parasites from vegetables used as the source of infection, may be helpful in judging the incidence of intestinal parasites among the Korean.

Althouh many surveys into the recovery of parasites from vegetables in Seoul areas have been conducted, the rate was inevitably high in all vegetables tested and little fluctuation in the rate has been observed during the past 40 years. This would seem to indicate that fecal contamination of vegetables has not reduced.

Our survey has been an attempt to approximate the recovery rate of parasites from vegetables in Taegu. Vegetation, especially in the southern and northern zones of Taegu is extremly dense, providing ideal cover. A number of vegetables are cultivated all the year round. Vegetables cultivated in the gardens, mainly young radish and Chinese cabbage, are sent to cities. Where markets are present, vegetables bought were used for making pickled vegetables. In this respect, the recovery rate of parasites in the present survey is not always limited to Taegu areas.

In the present study, the number of parasitic species recovered from vegetables was similar to that from the examination of human excreta, as seen in Tables 1, 2, and 3. This is in agreement with observations reported by Chiba (1928), Chyu(1957), Choi et al.(1967), Kwon et al.(1969) in Seoul areas, and by Lee (1969) in Taegu.

When the percentage recovery of parasites from vegetables was compared with human excreta, trichurid egg was fonnd least often in the former, while it was found most frequently in the latter. Likewise, the proportion of eggs found on vegetables is not necessarily the same as that of human excreta. The resultant observations in this study might be correlated to the worm burden and their daily egg output in hosts.

Vegetables cultivated in the farms, by order of government must be washed at the vegetable washing stand prior to being sold. A number of vegetables were insufficiently washed with tap water there. Although a moderate reduction in the number of parasites was observed, there was no significant reduction between washed vegetables and unwashed ones. The adequacy of a single forced washing is of questionable value. Howerver, it is apparent that washing greatly reduces the number of parasites in vegetables. Komiya et al. (1965), Kumada (1965) and Kobayashi et al. (1957) reached similar conclusions as to the remarkable elimination of parasites by washing.

Komiya et al. (1954) made a survey on the actual condition of vegetables as a transmitter of ascarid infection, and they stated that a simple washing at home is not effective for eliminating ascarid eggs from the leaves. This view agrees with the results reported by Oda (1927).

Results of surveys on recovery rates in monthly collections of young radish from July untitl October, showed a striking aspect; the rate was remarkably low in the case of hookworm eggs, while it contrasted sharply with filariform larva. The results of this svrvey, when compared to the data presented from other species of vegetables reported by Oda (1972) and by Choi et al. (1967), showed certain parallels. First, the recovery rate of ascarid eggs, as well as the number of parasitic species in our study, are similar to above worker's conclusions. Second, the monthly fluctuation of the rate was not so different from the results reported by Oda (1927).

Finally, the weight of vegetables vary so considerably that the mean number of parasite in a vegetable leaf causes some problems. Therefore, the mean number of parasites from vegetables must has been derived per 200 grams of vegetables. Further epidemiologic and correlated statistical analysis is required to test this problem.

SUMMARY

A parasitic survey on vegetables collected from markets and vegetable gardens in Taegu area was conducted for the discovery of human parasitic eggs and larvae. Three species of vegetable, lettuce (Lactuca sativa), young radish(Raphanus sapivus) and Chinese cabbage (Brassica pekinensis) were selected.

All vegetable leaves were washed with a hard brush, and then species of parasites and the approximate mean number of parasitic eggs per 200 grams of vegetable leaves were investigated.

When vegetables collected from markets were examined, 5 species of parasite eggs (ascarid, trichurid, *Trichostrongylus*, *Clonorchis* and hookworms) and 2 larvae(filariform and rhabditoid) were found. Furthermore, a number of eggs and larvae of undetermined species were also observed. Of the parasites studied, ascarid egg was found to be highest (49.0%), followed by *Trichostrongylus* egg (18.0%) as well as filariform larva of hookworms (19.7%), and the least often observed

was rhabditoid larva of hookworms(0.7%).

The recovery rate of parasites among lettuce, young radish and Chinese cabbage collected from markets ranged from 23.2 to 91.9 percent and was similar to that from vegetable gardens, where Chinese cabbage showed the highest (91.9%) and lettuce being next(49.0%) in positivity of ascarid eggs. In the case of filariform larva, the rate of Chinese cabbage was twice as high as that of lettuce and young radish.

There was a significant reduction in the rate of filariform larva, suggesting that a single washing of vegetables at the vegetable washing stand would reduce the number of parasites attached to vegetable leaves, when young radish washed at the stand was compared with that unwashed.

In the monthly rate of parasites recovered from young radish, there was significant fluctuations between the eggs and filariform larva of hookworms.

The mean number of ascarid egg per 200 grams of vegetable was 7.5 in young radishes, 3.1 in lettuces, and 0.5 in Chinese cabbages, in decreasing order. It is noteworthy that young radish contained more than 10 times more than Chinese cabbages. These results would seem to indicate that one of the important routes of infection is due to consumption of pickled young radishes in summer than pickled Chinese cabbages in winter.

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=국문초록=

대구지방의 시장과 채소밭에서 채집한 채소에서 기생충 검출

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대구지방의 시장과 채소밭에서 채집한 채소에서 인체 기생충난과 그유충을 검출하기 위해 상치 열무 배추 3종을 선택하여 기생충 조사를 하였다. 채소잎은 모두 야문 솔로 씻은 다음 채소잎에서 기생충의 종류와 200 gm 당 기생충난의 평균수를 조사 하였다. 시장에서 채소를 조사하였던 바 5종의 기생충난 회충 편충 모양선충 간디스토마및 구충과 2종의 유충—사상유충 간상유충을 검출할 수 있었고 그외 소속미정의 충난과 유충도 볼 수 있었다. 이중에서 회충난이 가장 많았고 (49.0%) 다음은 편충난 (18.0%)과 구충의 사상유충 (19.7%)이였으며 구충의 간상유충은 가장 적었다(0.7%).

시장에서 채집한 상치 열무 배추에서 기생충 검출율은 23.2%에서 91.9%였으며 채소밭에서 채집한 것과 비슷하였고 회충난의 검출율은 배추에서 가장 높았고 (91.9%) 다음은 상치 였다(49.0%).

사상유충의 검출율은 배추가 상치와 열무에 비해 2배나 높았다. 채소 세척장에서 씻은 열무와 안씻은 열무를 비교 하였을 때 사상유충의 검출율은 현저하게 떨어졌으므로 채소를 세척장에서 단 1회 세척으로 채소잎에 부착된 기생충난이 상당수 떨어져 나감을 알 수 있었다. 열무에서 기생충난의 월별 검출율은 구충의 충난과 사상유충사이에 유의적 변동을 볼 수 있었다. 채소 200 gm 당 회충난의 평균수는 열무에서는 7.5 상치는 3.1 배추는 0.5였다 특히 열무는 배추에 비해 10배 이상의 기생충난을 갖고 있는 것은 주목 할만한 것이다.

이상의 결과로 미루어 보아 여름철에 열무김치를 담아 먹는 것이 겨울철에 배추김치를 먹는 것보다 기생충 감염의 중요한 경로의 하나로 볼 수 있었다.