アワビ,ドジョウおよびブリに対する植物性生薬の誘引活性

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Attraction Activities of Herbal Crude Drugs for Abalone, Oriental Weatherfish, and Yellowtail*1

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The attraction activities of herbal crude drugs were statistically estimated on the basis of exploratory behavior of three aquatic test animals; the black abalone *Haliotis discus*, the oriental weatherfish *Misgurnus anguillicaudatus*, and the yellowtail *Seriola quinqueradiata*.

Among twenty-three herbal crude drugs, the common attractive drugs for all test animals were following three drugs; *Herba plectranthi* (*En'meisou* in Japanese) and *Phellodendron* bark (*Ohbaku*) of bitter stomachic, and sweet *Hydrangea* leaf (*Amacha*) of corrective. The most potent attractive drugs were *Amomum* seed (*Shukusha*) of fragrant and pungent stomachic for abalone, guarana seed (*Garana*) of cardiac stimulant for oriental weatherfish, and *Gentian* (*Genchana*) of bitter stomachic for yellowtail. The attraction activity of each of these drugs increased appreciably with the increase in concentration (0.1–3.0%) for oriental weatherfish and yellowtail, but decreased at high concentrations for abalone.

The previous papers have dealt with the attraction activities of spices of food substances foreign to aquatic environments.[1),*3] Among the attractive spices, marjoram, caraway, and cumin were highest in attraction activity for abalone *Haliotis discus*, oriental weatherfish *Misgurnus anguillicaudatus*, and yellowtail *Seriola quinqueradiata*, respectively. These spices did not induce any unusual behavior pattern of test animals during the experiment, and the test individuals swam into and away from the test compartment as in the test of attractants already reported,[2-4)] which are distributed in the aquatic animal environment. The results strongly support the possibility that the foreign food substances attract generally aquatic animals.

In the present paper, the attraction activity was examined with the water extract obtained from a variety of herbal crude drugs some of which are also spices, using three test animals above. Abalone, oriental weatherfish, and yellowtail are herbivorous, omnivorous, and carnivorous, respectively.

Materials and Methods

Test Animals

Young black abalone (1.4 cm average shell length at the initial of experiment) and juvenile yellowtail (8.0 cm average fork length at the initial) were supplied from Yamaguchi Prefecture Gaikai Fisheries Experimental Station and Senzaki Farm of Aquaculture in Yamaguchi prefecture, respectively. Adult oriental weatherfish (8.0 cm average body length) were purchased from an aquaculture farm in Shiga prefecture. The individuals used in the experiment were 50 abalone, 60 oriental weatherfish, and 53 (in final experiment) to 210 (in initial one) yellowtail. Test animals were maintained in the same manner as in the previous papers.[2-4)]

Estimation of Attraction Activity by Attraction Index

The estimation of the attraction index *a* (A. I. *a* for short) for both abalone and oriental weatherfish, and attraction index *gr* (A. I. *gr*) for yellowtail has been reported previously.[2-4)] Briefly *a* for abalone and oriental weatherfish was estimated on the basis of the number of the remained individuals by using the equation of logistic

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Table 1. Twenty-three herbal and one animal crude drugs used

Common name (Japanese name)	Family name	Botanical name
Bitter stomachic		
Aloe (*Aroe*)	Liliaceae	*Aloe ferox*
Coptis rhizome (*Ouren*)	Ranunculaceae	*Coptis chinencis*
Gentian (*Genchana*)	Gentianceae	*Gentiana lutea*
Herba plectranthi[*1] (*En'meisou*)	Labiatae	*Isodon japonicus*
Phellodendron bark (*Ohbaku*)	Rutaceae	*Phellodendro amurense*
Sophora root (*Kujin*)	Legminosae	*Sophora angustifolia*
Fragrant and pungent stomachic		
Amomum seed (*Shukusha*)	Zingiberaceae	*Amomum xanthioides*
Cinnamon bark (*Keihi*)	Lauraceae	*Cinnamomum cassia*
Citrus unshiu peel (*Chinpi*)	Rutaceae	*Citrus unshiu*
Fennel (*Uikyou*)	Umberlliferae	*Foeniculum vulgare*
Ginger (*Shoukyou*)	Zingiberaceae	*Zinziber officinale*
Immature orange (*Kijitsu*)	Rutaceae	*Citrus aurantium*
Roborant		
Astragalus root (*Ougi*)	Legminosae	*Astragalus mongholicus*
Coix seed (*Yokuinin*)	Graminae	*Coix lacryma-jobi* var. *nayuen*
Dioscorea rhizome (*Sanyaku*)	Dioscoreaceae	*Dioscorea batatus*
Fructus lycii[*1] (*Kukoshi*)	Solanaceae	*Lycium chinense*
Jujube (*Taisou*)	Rhamnaceae	*Zizyphus jujuba* var. *innermis*
Corrective		
Flos rosae rugosae[*1] (*Maikaika*)	Rosaceae	*Rosa rugosa* var. *plena*
Mentha herb (*Hakka*)	Labiatae	*Mentha arvensis* var. *piperascens*
Sweet *Hydrangea* leaf (*Amacha*)	Saxifragaceae	*Hydrangea serrata* var. *thunbergii*
Cardiac stimulant		
Digitalis (*Jikitalis*)	Scrophulariaceae	*Digitalis purpurea*
Guarana seed (*Garana*)	Spaindaceae	*Paullinia cupana*
Toad venom[*2] (*Senso*)	Bufonidae	*Bufo bufo gargorizans*
Stimulant		
Nux vomica (*Homika*)	Loganiaceae	*Strychnos nuxvomica*

[*1] Latin name, [*2] Animal crude drug.

curve $y=g/\{1+\exp[-r(x-a)]\}$, and *gr* for yellowtail was either on the number of the entered individuals or the left ones, according to the degree of fitness of the observed series to the equation. The significance test was conducted with 0.100 level by chi-square test. The crumpled gauze (a sheet of 25×25 cm), which soaked 7.5 m*l* of test sample as described below, was used for estimating A. I. *a* and *gr*.

Herbal Crude Drugs

Twenty-three herbal and one animal crude drugs were supplied from Shiono Koryo Co., Ltd. The drugs used were tentatively classified into six categories; bitter stomachic, fragrant and pungent stomachic, roborant, corrective, cardiac stimulant, and stimulant from the standpoint of functional action. The common and Japanese, family, and botanical names of the drugs used are listed in Table 1.

Preparation of Test Sample

The preparation of test sample was the same as described previously in that of spices.[1],[*3] A 3% water extract was prepared from each of ground drugs. The extract was, if necessary, adjusted to pH 6.5 by dilute sodium hydroxide or hydrochloric acid. The extract was used as the test sample for yellowtail, while its 3- and 30-fold solution were diluted from the original one by deionized water for oriental weatherfish and abalone, respectively.

Results

The effect of extraction time on attraction activity was tested using three representative herbal crude drugs, sweet *Hydrangea* leaf, *Amomum* seed and *Coptis rhizome* (Table 2). The activity of all drugs tested generally increased with the increase of extraction time for all test animals. Accordingly, the extraction time was fixed at 16 h in the preparation of test samples, because adequate activity for evaluating the attraction activity was found even in 16-h extracts.

The attraction activity of each of the herbal crude drugs was investigated (Table 3). Of the six drugs of bitter stomachic (Nos. 4 and 5), only *Phellodendron* bark and *Herba plectranthi* were common attractive drugs for all test animals. In abalone, the attraction activity of all bitter stomachics was higher than that of the dummy, and in particular *Coptis rhizome* and *Gentian* were strong in attraction. In oriental weatherfish, the attraction activity of *Phellodendron* bark and *Herba plectranthi* was higher than that of dummy, but weak in attraction. In yellowtail, the attraction activity of all bitter stomachics excluding *Aloe* was also higher than that of dummy, and especially *Gentian* and *Herba plectranthi* were strong in the attraction.

Of the six drugs of fragrant and pungent stomachic (Nos. 6 and 7), common attractive drugs for three test animals were not found. In abalone, the attraction activity of fennel and *Amomum* seed was higher than that of the dummy, and in particular the former drug was strong in the attraction. In oriental weatherfish, the attrac-

Table 2. Attraction activity of three herbal crude drug extracts over different extraction times for three test animals

No.	Extraction time (h)	Attraction activity* A	O	Y
		(A.I.*a*)	(A.I.*a*)	(A.I.*gr*)
	Sweet *Hydrangea* leaf			
1	0(dummy)	5.5†	1.8†	21.7†
	8	5.6†	2.1†	36.1†
	16	6.6†?	2.9†	39.7†
	24	8.9†?	3.8†	56.2†
	Amomum seed			
2	0(dummy)	6.7†?		37.1†
	8	8.3†		44.6†
	16	13.0†		59.7†
	24	15.1†?		102.2†
	Coptis rhizome			
3	0(Dummy)	4.1†		9.0†
	8	7.0†		24.9†
	16	5.8†?		27.9†
	24	8.9†		32.6†

* The *a* and *gr* of attraction index (A.I.) are derived from the coefficients of a logistic curve $y=g/\{1+\exp[-r(x-a)]\}$ being applied to remained and entered or left time-courses for abalone (A in abbreviation) and oriental weatherfish (O), and yellowtail (Y), respectively.

† and †?; $\Pr(\chi>\chi^2_{0.100})>0.100$ and slightly less than $\Pr=0.100$, respectively.

Table 3. Attraction activity of a variety of herbal crude drugs for three test animals

No.	Herbal crude drugs	Attraction activity A	O	Y
		(A.I.*a*)	(A.I.*a*)	(A.I.*gr*)
4	Dummy	4.6†?	2.2†	34.1†
	Aloe	5.8†?	2.2†	31.4†
	Coptis rhizome	7.7†	2.3†	42.3†
	Phellodendron bark	6.4†	2.7†	38.1†
5	Dummy	3.5†?	2.0†	12.3†
	Gentian	6.1†	1.9†	39.3†
	Herba plectranthi	5.4†	2.5†	31.8†
	Sophora root	5.4†	1.1†	20.2†
6	Dummy	7.5†?	1.6†	85.4†
	Cinnamon bark	6.1†	1.3†	122.6†
	Fennel	9.6†	2.4†	87.2†
	Immature orange	5.4†	2.1†	101.4†
7	Dummy	6.1†	2.7†?	62.1†
	Amomum seed	7.7†	2.8†	73.8†
	Citrus unshiu peel	6.4†	4.4†	55.8†
	Ginger	4.4†	2.7†	79.2†
8	Dummy	3.9†?	2.4†?	120.2†
	Astragalus root	6.8†	2.9†?	97.9†
	Diosocorea rhizome	9.7†	4.0†	94.1†
	Jujube	4.8†	3.2†?	104.8†
9	Dummy	11.3†	3.2†	81.2†
	Coix seed	7.8†	7.1†	78.0†
	Fructus lycii	6.9†?	4.3†	114.4†
	Nux vomica	8.0†	6.7†?	83.3†
10	Dummy	7.9†	2.3†	87.1†
	Digitalis	7.9†	3.1†	68.0†
	Mentha herb	5.9†	4.8†	91.8†
	Sweet *Hydrangea leaf*	11.0†	4.0†?	101.3†
11	Dummy	25.6†?	2.3†	96.3†
	Flos rosae rugosae	6.6†?	1.5†	32.9†
	Guarana seed	12.0†?	5.7†	72.7†
	Toad venom	7.8†	0.2†?	57.2†

Signs; as legends in Table 2.

Table 4. Comparative test of attractive herbal crude drugs for three test animals

No.	Herbal crude drugs	Attraction activity	No.	Herbal crude drugs	Attraction activity
	A; Abalone	(A.I.*a*)			(A.I.*a*)
12	Dummy	6.0†	13	Dummy	—
	Coptis rhizome	9.1†		*Amomum* seed	12.0†
	Gentian	8.4†		Fennel	9.6†
	Phellodendron bark	7.3†		*Herba plectranthi*	6.9†
14	Dummy	6.9†	15	Dummy	—
	Astragalus root	8.4†		*Amomum* seed	10.4†
	Dioscorea rhizome	9.1†		*Coptis rhizome*	6.1†
	Sweet *Hydrangea* leaf	9.9†		Sweet *Hydrangea* leaf	9.9†
	O; Oriental weatherfish	(A.I.*a*)			(A.I.*a*)
16	Dummy	1.1†	17	Dummy	—
	Fennel	1.4†		*Citrus unshiu* peel	1.1†
	Herba plectranthi	2.4†		*Coix* seed	2.5†
	Phellodendron bark	3.3†		*Dioscorea rhizome*	1.6†
18	Dummy	—	19	Dummy	—
	Guarana seed	3.7†		*Coix* seed	3.1†
	Mentha herb	1.8†		Guarana seed	5.2†
	Sweet *Hydrangea* leaf	3.1†		*Phellodendron* bark	2.3†
	Y; Yellowtail	(A.I.*gr*)			(A.I.*gr*)
20	Dummy	65.4†	21	Dummy	49.5†
	Coptis rhizome	74.6†		*Amomum* seed	80.2†
	Gentian	95.4†		*Cinnamon* bark	66.1†
	Herba plectranthi	70.0†		Ginger	53.4†
22	Dummy	74.3†	23	Dummy	—
	Fructus lycii	96.1†		*Amomum* seed	62.7†
	Immature orange	113.5†		*Gentian*	75.8†
	Sweet *Hydrangea* leaf	134.5†		Sweet *Hydrangea* leaf	60.4†

Signs; as legends in Table 2. —; Not estimated.

tion activity of fennel, immature orange and *Citrus unshiu* peel was higher than that of dummy. In yellowtail, the attraction activity of *Cinnamon* bark, immature orange, *Amomum* seed and ginger was higher than that of dummy, and especially *Cinnamon* bark was strong in the attraction.

Among five roborant and one stimulant drug (Nos. 8 and 9), common attractive drugs were not found. In abalone, the attraction activity of *Astragalus* root, *Diosocorea rhizome*, and *Jujube* was higher than that of dummy, and in particular *Diosocorea rhizome* was strong in the attraction. In oriental weatherfish, the attraction activity of all roborants and one stimulant was higher than that of dummy, and *Coix* seed was particulary strong in the attraction. In yellowtail, the attraction activity of only *Fructus lycii* was higher than that of dummy.

Among three corrective and three cardiac stimulant drugs (Nos. 10 and 11), only sweet *Hydrangea* leaf was commonly attractive drug for all test animals. In abalone, the attraction activity of only the leaf was higher than that of the dummy. In oriental weatherfish, the attraction activity of *Digitalis*, *Mentha* herb, sweet *Hydrangea* leaf, and guarana seed was higher than that of dummy, and the last drug in particular was strong in the attraction. In yellowtail, the attraction activity of only *Mentha* herb and sweet *Hydrangea* leaf was higher than that of dummy. The drug like toad venom (No. 11), which is extremely lower in attraction activity than the dummy, may be a repellent in contrast to an attractant. This can be judged from the phenomena that the number of individuals entering the test compartment contained such as the venom and the remained time in the compartment were few and short, respectively.

In order to determine the strongest attractants among the attractive herbal crude drugs indicated above (Table 4), three series (Nos. 12–14 for abalone, Nos. 16–18 for oriental weatherfish, Nos. 20–22 for yellowtail) of arbitrarily chosen combinations of three of the nine drugs with high attraction activity were firstly examined. Furthermore, on the basis of the results of the series above, the combination of three higher attractive drugs was secondly tested. In the final experiment (No. 15 for abalone, No. 19 for oriental weatherfish, No. 23 for yellowtail), the attraction activity of *Amomum* seed, guarana seed, and *Gentian* was highest for abalone, oriental weatherfish and yellowtail, respectively.

The relationship between attraction activity and concentration was tested on *Amomum* seed, guarana seed, and *Gentian* (Fig. 1). The attraction activity was examined with different concentrations diluted from the original extract (3%). The attraction activity increased appreciably with increases in the concentrations (0.1–3.0%) for both oriental weatherfish and yellowtail. On the other hand, the attraction activity of *Amomum* seed for abalone decreased with increase in the concentration at high concentrations (0.1–3.0%), though it increased at low concentrations (0.01–0.1%).

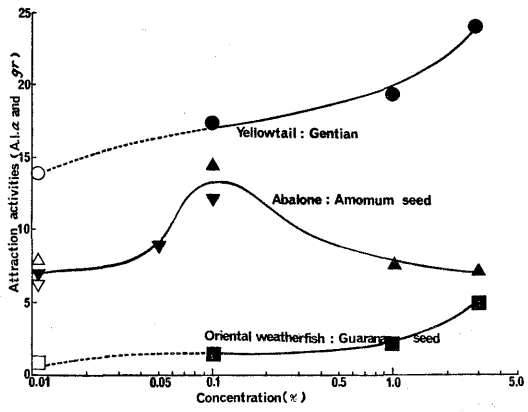

Fig. 1. Effect of the concentrations of strong attractive drugs on attraction activities for three test animals.

Same symbol shows simultaneous experimental series, while its open symbol indicates a dummy.

Discussion

Though aquatic animals have no opportunity to feed on terrestrial plants, some of them were found to attract and/or stimulate the aquatic invertebrates and vertebrates.[1),*3] For example, a lettuce *Lactuca sativa* var. *longifolia* attracts a snail *Australorbis glabratus*[5)] and also stimulates a cichild fish *Tilapia zillii*.[6)] On the other hand, terrestrial animals such as silkworm pupae, beef liver, and so on also attract and/or stimulate aquatic animals.[7–13)]

The extent of the attraction activity obtained from our experiments, and the general characteristics of herbal crude drugs[14,15)] were collectively summarized in Table 5. Extent is based on the comparison between the attraction indexes of drugs and dummy: the strong and the weak in the table were in the case of remarkably and faintly higher than the index of a dummy, respectively. Among twenty-three herbal crude

Table 5. Attraction effect and characteristics of herbal crude drugs

Common name	Attraction effect			Characteristic[14,15)]	
	A	O	Y	Organoleptic	Main components
Bitter stomachic					
Aloe	*			Specific odor, bitter	Barbaloin
Coptis rhizome	**		*	Specific odor, bitter	Berberine
Gentian	**		**	Specific odor, sweet, and bitter	Gentiopicrin
Herba plectranthi	**	*	**	Black tea odor, bitter	Plectranthin
Phellodendron bark	**	*	*	Specific odor, bitter	Berberine
Sophora root	**		*	Specific odor, bitter	Matrine
Fragrant and pungent stomachic					
Amomum seed	**		**	Specific odor, pungent	Borneol
Cinnamon bark			**	Specific odor, sweet, and pungent	Cinnamaldehyde
Citrus unshiu peel		**		Aromatic, bitter	Limonene
Fennel	**	*		Anethole odor, sweet	Anethole
Ginger			**	Specific odor, pungent	Zingiberol
Immature orange		*	**	Specific odor, bitter	Limonene

Table 5. (Cont'd)

Common name	Attraction effect			Characteristic[14,15]	
	A	O	Y	Organoleptic	Main components
Roborant					
Astragalus root	**	*		Specific odor, sweet	2′,4′-dihydroxy-5,6-dimethoxy-isolflavone
Coix seed		**		Specific odor, sweet	Starch, protein, fatty acid
Dioscorea rhizome	**	**		Non-odor, non-taste	Starch, glycoprotein, amino acid
Fructus lycii		*	**	Specific odor, sweet, and bitter	Betaine
Jujube	*	*		Specific odor, sweet	Triterpene
Corrective					
Flos rosae rugosae				Specific odor, non-taste	?
Mentha herb		**	*	Specific odor, refreshing	Menthol
Sweet *Hydrangea* leaf	**	**	**	Specific odor, sweet	Phyllodulcin
Cardiac stimulant					
Digitalis		*		Specific odor, bitter	Digitoxin, giotoxin
Guarana seed		**		Specific odor, bitter	Caffeine
Toad venom				Non-odor, bitter	Resibufogenin
Stimulant					
Nux vomica		**		Non-odor, bitter	Strychnine

*,**; Weak and strong (cf. text). Abbreviation (A, O, Y); as legends in Table 2.

drugs, common attractive drugs for three test animals were following three drugs; *Herba plectranthi*, *Phellodendron* bark, and sweet *Hydrangea* leaf. The last drug was the most potent attractant. About half of the drugs tested were somehow effective to each of test animals, if the extent was disregarded. The attraction behavior of the test animals to these drugs was usual and in the same manner as described previously.[1-4),*3] Abalone and yellowtail in particular may generally accept bitter herbal crude drugs, while oriental weatherfish might accept sweet ones. Most drugs have an interesting specific compound, judging from the main component in the drugs used. Such a finding suggests the possibility of discovering a new attractant for aquatic animals.

References

1) K. Harada: *Nippon Suisan Gakkaishi*, **56**, 2029–2033 (1990).
2) K. Harada, H. Maéda, and K. Kobayashi: *Nippon Suisan Gakkaishi*, **48**, 21–29 (1982).
3) K. Harada and O. Kawasaki: *Nippon Suisan Gakkaishi*, **48**, 617–621 (1982).
4) K. Harada: *Nippon Suisan Gakkaishi*, **48**, 1047–1054 (1982).
5) E. H. Michelson: *Am. J. Trop. Med. Hyg.*, **9**, 480–487 (1960).
6) P. B. Johnsen and M. A. Adams: *Comp. Biochem. Physiol.*, **83A**, 109–112 (1986).
7) J. M. D. Olmsted: *Am. J. Physiol.*, **46**, 443–458 (1918).
8) J. R. Mcbride, D. R. Idler, R. E. E. Jonas, and N. Tomlinson: *J. Fish. Res. Bd. Can.*, **19**, 327–334 (1962).
9) M. Takei: *Bull. Tokai Reg. Fish. Res. Lab.*, No. **49**, 119–129 (1967).
10) J. Tsushima and K. Ina: *Nippon Nōgeikagaku Kaishi*, **52**, 225–229 (1978).
11) K. Harada: *Nippon Suisan Gakkaishi*, **49**, 521–526 (1983).
12) S. Murofushi and K. Ina: *Agric. Biol. Chem.*, **45**, 1501–1504 (1981).
13) K. Harada and A. Ohwada: *Nippon Suisan Gakkaishi*, **49**, 1541–1546 (1983).
14) Association of Japanese Official Document: The Commentary of the Japan Pharmacopeia, Hirokawa, Tokyo, 1981, D.E.F.
15) Committee of Pharmaceutical: Pharmaceutical Lexicon, Seibundo-shinkousha, Tokyo, 1958, pp. 1–1794.