

Disorders in Cabbage, Bunched Broccoli, and Cauliflower Shipments to the New York Market, 1972–1985

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Cabbage (*Brassica oleracea* var. *capitata* L.), bunched sprouting broccoli (*B. oleracea* var. *italica* L.), and cauliflower (*B. oleracea* var. *botrytis* L.) are the principal crucifers consumed in the United States. All three crops are widely grown, but California is the principal supplier of cauliflower (70%) and broccoli (90%) for the fresh market (19). Until recently, cabbage was the leading crucifer shipped to New York City markets (17,18). Its volume has been declining annually, however, while that of broccoli and cauliflower has been increasing (Table 1). The consumption of cruciferous vegetables is expected to increase because of their alleged ability to protect against intestinal cancer (14,16).

This report is a continuation of a series (1–12) on the arrival condition of fresh produce shipped to the New York market. Field and market researchers concerned with maintaining the market quality of cruciferous vegetables should find this information useful in planning strategies to reduce losses from diseases and other disorders. This report was derived from computerized data initially abstracted from USDA inspection certificates.

USDA personnel examined 6,441 shipments of cabbage, broccoli, and cauliflower at New York terminal markets during 1972–1985 (Table 2). To arrive at a reliable appraisal of product quality in a shipment, six containers (cartons, crates, or sacks) of a commodity are routinely inspected; if necessary, more containers are inspected. Diseases and other disorders are either named or described by symptomatology.

Cabbage. Eight parasitic diseases, nine physiological disorders, and five types of injury were reported in 1,952 cabbage inspections (Table 3). About one-half of the 2,891 occurrences of disorders were due to parasitic diseases, with bacterial soft rot (*Erwinia* and *Pseudomonas* spp.) accounting for more than 80% of these. Yellowing of the outer leaves and grade defects were the most frequently reported physiological disorder and injury, respectively.

Bacterial soft rot was reported in 60% of the cabbage shipments and was distributed from the lowest incidence class (1–5% heads affected) to the highest (>50% heads affected) (Table 4). Other noteworthy diseases were *Alternaria* rot (*Alternaria* sp.), watery soft rot (*Sclerotinia sclerotiorum*), black rot (*Xanthomonas campestris* pv. *campestris*), and gray mold rot (*Botrytis cinerea*). Unidentified decays were reported in a considerable number of shipments but mostly in the lowest incidence class. (Inspectors often do not name a disease when the decay does not affect the grade tolerance or when symptoms are not fully developed or are unrecognized.) A number of nonparasitic disorders were reported in all incidence classes, with yellowing, black discoloration, and bruise damage noted more frequently than tipburn and surface discoloration. Freeze damage was also reported in all incidence classes, with >50% of the heads damaged in about one-half of the affected shipments.

Important disorders of the leading cabbage cultivars from the main sources of supply are shown in Table 5. Parasitic diseases and other disorders were reported less frequently in the Chinese

cultivar than in the Domestic cultivar. Proportionately more bruising was reported in New York cabbage shipments despite proximity of the producing areas to the market. Interestingly, no reports were made of *Alternaria* rot, watery soft rot, or gray mold rot in the inspected California shipments. Inspections of the Danish cultivar from Holland revealed high incidences of bacterial soft rot as well as more black rot than reported in domestic shipments.

Broccoli. Five parasitic diseases, five physiological disorders, and three types of injury were reported in USDA inspections of 1,967 bunched broccoli shipments (Table 6). California shipments accounted for 93% of the inspections. Advanced maturity of bud clusters, manifested by enlargement and/or yellowing, was noted more frequently than the parasitic diseases. These disorders have a much higher tolerance than the more damaging diseases and are more likely to be marketed, although discounted.

Most of the parasitic disease occurrences were bacterial soft rot (*Erwinia* and *Pseudomonas* spp.). This disease was reported in all incidence classes, and its destructiveness in the high incidence classes probably resulted in total loss of some shipments. Gray mold rot (*B. cinerea*) occurred in fewer shipments but was found in all incidence classes and was equally destructive. Unidentified decays were reported in a substantial number of shipments but almost always in the lowest incidence class. Undoubtedly, many of these decays were bacterial soft rot. In the early 1970s, some winter shipments of broccoli arrived in a malodorous condition that may have been reported as an unidentified decay until shown to be suboxidation by Kasmire et al (13). Rhizopus rot (*Rhizopus* sp.) and watery soft rot (*S. sclerotiorum*) occurred in less than 1% of the inspected shipments.

Table 1. Volume of cabbage, broccoli, and cauliflower shipped to the New York market, 1972–1985

Year	Number of 45,400-kg units		
	Cabbage	Broccoli	Cauliflower
1972	1,075	269	170
1973	1,198	247	175
1974	1,178	269	178
1975	1,211	328	174
1976	1,050	182	97
1977	1,037	199	124
1978	1,039	211	80
1979	759	250	97
1980	968	261	144
1981	1,041	354	266
1982	885	438	226
1983	879	489	201
1984	700	569	214
1985	650	714	221
Total	13,670	4,780	2,367

Table 2. Volumes of cabbage, broccoli, and cauliflower in shipments inspected by USDA on the New York market, 1972–1985

Year	Cabbage		Broccoli		Cauliflower	
	Shipments (no.)	Packs ^a (no.)	Shipments (no.)	Packs ^b (no.)	Shipments (no.)	Packs ^c (no.)
1972	342	161,411	386	232,646	231	166,566
1973	324	167,662	98	61,339	111	82,081
1974	188	95,255	76	58,462	64	51,332
1975	110	51,641	70	48,755	136	98,159
1976	105	58,273	44	36,488	99	65,533
1977	103	58,970	38	38,935	82	54,641
1978	105	60,129	33	27,116	59	32,674
1979	64	29,806	70	51,564	74	42,311
1980	36	16,933	79	74,109	138	64,702
1981	62	32,244	75	44,173	179	81,346
1982	117	46,315	105	72,309	184	93,431
1983	89	44,669	258	205,053	382	198,972
1984	172	90,987	240	176,285	351	220,604
1985	135	67,339	395	298,264	432	311,617
Total	1,952	981,634	1,967	1,425,498	2,522	1,563,969

^a Carton, crate, or sack with net weight of 22.7 kg.^b Carton or crate with net weight of 10.5 kg.^c Film-wrapped carton or crate with net weight of 10.0 or 27.2 kg, respectively.**Table 3.** Disorders reported in USDA inspections of 1,952 cabbage shipments on the New York market, 1972–1985

Parasitic diseases	Shipments (no.)	Physiological disorders	Shipments (no.)	Injuries	Shipments (no.)
Bacterial soft rot	1,175	Yellowing	372	Grade defects	411
Unidentified decays	107	Black discoloration	250	Bruise damage	193
Alternaria rot	44	Sunken discoloration	75	Insect damage	40
Watery soft rot	27	Tipburn	59	Freeze damage	30
Black rot	27	Surface discoloration	24	Sunscald	1
Alternaria leaf spot	25	Burst heads	23		
Gray mold rot	21	Internal black discoloration	6		
Black leg	1	Black leaf speck	2		
		Shriveling	2		

Table 4. Frequency of disorders reported in USDA inspections of 1,952 cabbage shipments on the New York market, 1972–1985

Disorder	Shipments affected (%)	Number of shipments affected according to incidence class (% heads)						
		0	1–5	6–10	11–20	21–33	34–50	> 50
Bacterial soft rot	60.2	777	275	301	274	158	80	87
Grade defects ^a	21.1	1,541	184	186	17	21	2	1
Yellowing	19.1	1,580	95	87	107	46	14	23
Black discoloration	12.8	1,702	93	75	56	19	4	3
Bruise damage	9.9	1,759	91	57	36	6	1	2
Unidentified decays	5.5	1,845	100	3	3	1	0	0
Sunken discoloration	3.8	1,877	25	19	21	4	4	2
Tipburn	3.0	1,893	21	22	7	1	2	6
Alternaria rot	2.3	1,908	16	12	8	5	3	0
Insect damage	2.0	1,912	20	11	7	2	0	0
Freeze damage	1.5	1,922	1	1	4	2	6	16
Watery soft rot	1.4	1,925	4	7	6	6	2	2
Black rot	1.4	1,925	5	7	10	4	1	0
Alternaria leaf spot	1.3	1,927	6	3	10	2	4	0
Surface discoloration	1.2	1,928	2	4	11	2	4	1
Burst heads	1.2	1,929	11	6	3	3	0	0
Gray mold rot	1.1	1,931	5	7	3	4	2	0
Miscellaneous ^b	0.6	1,940	3	2	2	4	0	1

^a Minor mechanical damage, old worm and insect injuries, poor trimming of heads, presence of dirt and other foreign substances, and unidentified defects.^b Internal black discoloration, black leaf speck, shriveling, black leg, and sunscald.

Table 5. Parasitic and other disorders reported in USDA inspections of cabbage shipments from main sources of supply on the New York market, 1972-1985

Source	Shipments (no.)	Disorders and percentage of shipments affected									
		Bacterial soft rot	Unidentified decays	Alternaria rot	Watery soft rot	Black rot	Alternaria leaf spot	Gray mold rot	Bruise damage	Yellowing	Black discoloration
Florida	775	67.1	6.1	3.2	1.9	1.4	0.5	1.0	9.4	18.6	11.5
Domestic	622	71.5	5.5	4.0	1.9	1.8	0.6	1.1	10.0	21.9	13.9
Chinese	74	32.4	9.5	0	1.4	0	0	1.4	5.4	1.4	0
Texas	488	45.3	3.3	0.8	1.6	0.4	0.6	0.2	7.8	23.0	16.4
Domestic	348	49.7	4.0	0.3	1.7	0.6	0.9	0	9.5	23.9	20.4
Savoy	71	35.2	1.4	1.4	1.4	0	0	1.4	2.8	26.8	11.3
Holland	130	75.4	3.1	4.6	0	6.2	2.3	4.6	10.8	5.4	16.2
Danish	102	78.4	2.0	4.9	0	6.9	3.0	4.9	11.8	6.9	18.6
New York	114	71.9	9.6	2.6	0	2.6	0.9	3.5	25.4	2.6	12.3
Domestic	76	67.1	13.2	2.6	0	1.3	1.3	1.3	31.6	3.9	11.8
California	109	33.0	8.3	0	0	0.9	8.3	0	5.5	28.4	17.4
Domestic	93	38.7	9.7	0	0	1.1	9.7	0	5.4	33.3	18.3

Table 6. Frequency of disorders reported in USDA inspections of 1,967 bunched broccoli shipments on the New York market, 1972-1985

Disorder	Shipments affected (%)	Number of shipments affected according to incidence class (% bunches)						
		0	1-5	6-10	11-20	21-33	34-50	> 50
Yellow bud clusters	53.7	911	210	288	344	124	59	31
Enlarged buds	21.6	1,543	99	106	191	23	2	3
Yellowing	13.5	1,702	21	33	165	30	8	8
Bacterial soft rot	12.8	1,715	127	60	34	13	7	11
Dark discoloration	6.0	1,848	30	33	38	9	4	5
Unidentified decays	5.7	1,854	110	2	1	0	0	0
Bruise damage	5.2	1,865	40	31	13	17	1	0
Gray mold rot	3.9	1,891	26	15	11	15	5	4
Freeze damage	1.9	1,930	2	10	4	11	7	3
Soft/flaccid	0.5	1,957	3	3	4	0	0	0
Rhizopus rot	0.3	1,962	1	2	0	2	0	0
Insect damage	0.4	1,959	8	0	0	0	0	0
Watery soft rot	0.1	1,966	0	0	1	0	0	0

A condition described by the USDA inspectors as a dark discoloration also was reported in all incidence classes and apparently caused considerable damage. The etiology of this disorder should be investigated. Bruising and freezing were the other important damaging disorders.

Cauliflower. Eleven parasitic diseases, six physiological disorders, and three types of injury were identified or described in USDA inspections of 2,522 cauliflower shipments (Table 7). Most inspections (88%) were conducted on California shipments. The leading parasitic disease was bacterial soft rot and the leading physiological disorder was brown discoloration of the curd. Because of its relationship to brown discoloration, bruise damage probably occurred more often than cited.

Bacterial soft rot (*Erwinia* and *Pseudomonas* spp.) was reported in 57% of inspected shipments and accounted for 72% of all disease occurrences. Its seriousness is well illustrated by the substantial number of shipments in the high incidence classes. Jacket leaf decay (probably bacterial soft rot) occurred in fewer shipments and in some cases could have been associated with decay of the curd. Unidentified decays, as with broccoli and cabbage inspections, occurred in substantial numbers, with nearly all in the lowest incidence class. Although *Alternaria* rot (*Alternaria* sp.) was reported infrequently, brown discoloration in some shipments was probably the early stages of brown rot (*A. brassicae*) (15). All the other diseases were noted in less than 1% of the inspections.

We listed brown discoloration as a physiological disorder

because the symptoms usually develop progressively after an external stimulus. Bruising, in addition to *Alternaria*, was unquestionably a factor. Fuzziness and riciness describe a curd surface that is, respectively, pubescentlike and abnormally rough. These disorders and "spreading" of the curd are not considered particularly damaging in commerce. Freezing, on the other hand, occurred in relatively few shipments but caused extensive damage.

Summary. The data reported here do not represent the general condition of the three cruciferous crops on arrival on the New York market during 1972-1985. USDA inspections in most cases were because the quality of a shipment was suspect or impaired by transit delays or failure of protective services. The contents in the inspected shipments comprised about 4% of cabbage, 7% of broccoli, and 15% of cauliflower volumes delivered. Nonetheless, inspection of so many shipments by trained personnel over 14 years illustrates the seriousness of specific diseases and other disorders that continue to distress these crops during marketing. The preeminence of soft rot bacteria in parasitizing cabbage, broccoli, and cauliflower should come as no surprise. The frequency and magnitude of bacterial soft rot in shipments presumed to be initially sound, however, calls for rectification. No doubt, inappropriate handling and inadequate temperature control provided suitable conditions for invasion by opportunistic soft rot bacteria. The information in this report should be of value to those parties interested in improving quality and reducing losses in the marketing of cruciferous crops.

Table 7. Frequency of disorders reported in USDA inspections of 2,522 cauliflower shipments on the New York market, 1972-1985

Disorder	Shipments affected (%)	Number of shipments affected according to incidence class (% heads)						
		0	1-5	6-10	11-20	21-33	34-50	> 50
Brown discoloration	81.6	464	272	357	879	377	126	47
Bacterial soft rot	57.5	1,071	447	522	297	116	44	25
Jacket leaf decay	13.9	2,172	202	74	42	22	5	5
Fuzziness	12.8	2,199	72	90	88	58	9	6
Yellowing	8.0	2,321	61	45	50	26	10	9
Unidentified decays	6.7	2,354	163	2	3	0	0	0
Riciness	5.7	2,377	47	46	37	14	1	0
Spreading	5.1	2,394	53	44	23	5	3	0
Freeze damage	1.4	2,487	1	5	7	10	6	6
Alternaria rot	1.1	2,495	1	7	8	6	3	2
Bruise damage	1.1	2,495	14	7	5	1	0	0
Gray mold rot	0.4	2,513	2	3	3	1	0	0
Insect damage	0.4	2,513	5	4	0	0	0	0
Black surface mold	0.2	2,517	5	0	0	0	0	0
Rhizopus rot	0.1	2,519	0	1	1	1	0	0
Miscellaneous ^a	0.2	2,517	3	0	2	0	0	0

^a Watery soft rot, brown rot, Fusarium rot, cottony leak, and soft heads.

ACKNOWLEDGMENT

We thank the New York office of the USDA Fresh Fruit and Vegetable Inspection, Fresh Products Branch of the Agricultural Marketing Service for making available the inspection certificates from which the data for this report were obtained.

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