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1969 EVALUATIONS OF SOME PESTICIDE RESIDUES IN FOOD

THE MONOGRAPHS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

Rome, 1970

ETHOXYQUIN

IDENTITY

Chemical name

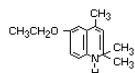
6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline or
1,2-dihydro-6-ethoxy-2,2,4-trimethylquinoline.

Synonym

Stop Scald, Santoquin

In some countries formulations containing ethoxyquin may appear under different trade names.

Structural formula



Other relevant chemical properties

The technical material as manufactured in the USA (Santoquin) is claimed to contain 100 percent active ingredients, but is not 100 percent ethoxyquin. E.g. "Stop Scald" is a 70 percent emulsion of Santoquin in water with added emulsifiers. It is a dark liquid varying in color from yellow to black. The color is claimed to be independent of the antioxidant or biological activity of the chemical.

Boiling Point: 125°C at 1-2 mm Hg.

Specific gravity: 1.028 to 1.032

Solubility: Miscible with animal and vegetable fats and oils.
Insoluble in water.

Viscosity at:

32°F	20,000	centipoises
73	197	"
122	17	"
158	7	"

(Monsanto, 1958).

EVALUATION FOR ACCEPTABLE DAILY INTAKE

BIOCHEMICAL ASPECTS

Absorption, distribution and excretion

Studies in chickens resulted in a 99 percent recovery of a single dose of C¹⁴-labelled ethoxyquin within 48 hours. Continuous administration of 125-137 ppm of ethoxyquin in the diet resulted in accumulation of approximately 0.1 ppm of ethoxyquin and/or its metabolites in the liver and fat per week during the first 12 weeks. Accumulation in muscle and other edible tissue was barely detectable. Withdrawal of ethoxyquin from the diet resulted in a loss of 79-90 percent of the tissue residue in a 6 to 18 hour period. The excretion products comprised 15 percent unchanged ethoxyquin, the remainder probably being N-glucuronide and N-acetyl derivatives (Monsanto, 1956).

When ethoxyquin was given in the diet of rats for 10 days at a concentration of 50 ppm, accumulation in the liver (2.1 - 4.8 ppm) and kidney (2.1 - 2.7 ppm) was observed. Concentrations in fat and skeletal muscle were less than 1 ppm (Wilson, 1956a; Wilson et al., 1959).

Rats preconditioned for several weeks on a diet containing 50 ppm of unlabelled ethoxyquin were given a single oral dose of 1.5 mg of ethoxyquin C¹⁴-labelled in the 2 and 4 positions of the heterocyclic ring. In two days 30 percent of the radioactivity was excreted in urine, 34 percent in faeces. In four days and seven days 40-60 percent and 58 percent was excreted in respectively, and 30-40 percent and 36 percent was excreted in faeces respectively. C¹⁴-carbon dioxide in respired air was detected on the first day only, and comprised 0.7 percent of the administered dose (Wilson, 1956a; Wilson et al., 1959).

In rats, repeated administration of ethoxyquin results in residues in the kidney as well as in the fat and liver. A greater degree of metabolic breakdown may occur than in chicken, because about 1 percent of the C¹⁴ administered is exhaled as C¹⁴-carbon dioxide in rats as compared with 0.2 percent in chickens (Monsanto, 1956).

Pregnant rats treated as above, and administered the labelled ethoxyquin nine days prior to parturition indicated that placental transfer of ethoxyquin occurs, because newborn young contained 0.12 to 0.21 ppm ethoxyquin in their tissues. Milk samples from two female rats fed a diet of 50 ppm of ethoxyquin for 10 days had residues in milk of 0.12 ppm and 0.19 ppm (Wilson, 1956a; Wilson et al., 1959).

Metabolic studies in dog indicated that ethoxyquin, per se, is not excreted in the urine to any appreciable extent, but is excreted as four unidentified metabolites (probably glucuronates). There was no evidence of the ethoxy-group being split from the molecule during metabolism. Results demonstrated that elimination is chiefly by the kidneys and only to a small degree by way of the faeces (Hanzal, 1955).

TOXICOLOGICAL STUDIES

Special studies on reproduction

Rat

After 40 days on a slightly tocopherol-deficient diet containing 0, 250, 500 or 1000 ppm ethoxyquin, rats were bred to produce three consecutive litters. The first litter offspring were utilized to produce a second generation litter. The top dose level was discarded after production of one litter. No effects on reproduction, as reflected by fertility, litter size, or survival of offspring were observed. The animals receiving the experimental diet produced young and raised them more successfully than the controls. The 500 ppm diet was more effective than the 250 ppm (Wilson, 1956b; Wilson and DeEds, 1959).

Groups, each of from five to nine rats, one to ten days pregnant, were fed 0, 125, 375 or 1125 ppm ethoxyquin in the diet. Litter size, stillbirths, survival to weanling, and weanling weights were all comparable to the control rats (Derse, 1956).

Groups, each of eight or nine female rats, were placed on diets containing 0, 125, 375 or 1125 ppm ethoxyquin on the day of mating. Gestation time was comparable in all groups. However, litter size was slightly depressed at the 375 ppm level and above, and at 1125 ppm incidence of stillbirths was increased, and survival to weaning was decreased (Derse, 1956).

Acute toxicity

Animal	Route	LD ₅₀	References
		mg/kg body-weight	
Mouse	i.p.	800-1000	Wilson and DeEds, 1959
Mouse	i.v.	178	Wilson and DeEds, 1959
Mouse	inhalation	3000	Kel'man, 1965
Rat	oral	ca.800	Wilson and DeEds, 1959
Rat	inhalation	3150	Kel'man, 1965
Chicken	oral	8000-10000	Maclay, 1954

Short-term studies

Chicken

Six groups of 70 four-day old cockerels were fed 0, 7.5, 15, 30, 75 or 750 ppm ethoxyquin in the diet for 12 weeks. No adverse effects were observed on body-weight, food-consumption, mortality, gross-, or histopathology (Maclay, 1954).

No adverse effects were observed in cockerels fed diets containing 7.5, 15, 30, 75 or 750 ppm ethoxyquin for 12 weeks (Colorado A. and Experimental Station, ca. 1954).

Nor were any adverse effects observed in chicks fed diets containing 75, 750 or 1500 ppm for eight weeks (Halloran, 1952).

Chicks were fed 0.25 percent of ethoxyquin in their diet for six weeks. The concentration of ethoxyquin in the livers was significantly higher when the dietary level of protein was 17 percent than when the level was 23 percent. (March et al., 1968).

Dog

Mixed groups, each of three dogs, were given oral doses by capsule five times weekly for one year at dose-levels of 0, 3, 10, 50 or 100 mg/kg body-weight. Feeding the 100 mg/kg group was terminated after six weeks due to toxic effects, and the dogs were sacrificed at nine weeks. One female animal at 3 mg/kg developed histoplasmosis about 40 weeks after initiation of the study, resulting in abnormal findings when compared to the control dogs. All such finding could be attributed to the infection. In the remaining animals body-weight was depressed at 100 mg/kg; bromosulphthalein retention was increased at 10 mg/kg and above, indicating liver dysfunction; abdominal tenderness was apparent in two of three dogs (male) at 10 mg/kg, and in two of three dogs (one male and one female) at 50 mg/kg; erythrocyte sedimentation rate was increased in one of three dogs at 50 mg/kg, and in all three dogs at 100 mg/kg; haemograms showed reduced haematocrit, haemoglobin, and erythrocyte counts in two of three dogs at 50 mg/kg, and in all dogs at 100 mg/kg; urin-analysis indicated dark amber, green or blackish brown urine at 50 and 100 mg/kg; there was increased heart, liver, and kidney to body-weight ratios in all dose-levels, but there does not appear to be any dose relationship in these increases; histopathology indicated liver-stress, and fatty renal nephrosis at the 10, 50 and 100 mg/kg dose-levels (Hanzal, 1955).

Rabbit

Undiluted ethoxyquin emulsion (70 percent) was applied to the clipped intact skin of three rabbits, and removed after 24 hours. Slight erythema occurred after 24 hours in all animals with barely

perceptible redness remaining after 48 hours in only one animal. The compound was classed as a mild skin-irritant under the conditions described (Kelly 1960).

Rat

Three groups of 10 male and 10 female rats which were fed 0, 0.2, and 0.4 percent ethoxyquin in their diet for 200 days displayed an initial depression in growth rate (statistically significant only at the 0.4 level) in both test groups. The weight loss was not recovered during the course of the experiment. Haemograms in all groups were comparable. At autopsy, liver and kidney weights were elevated in both sexes in both test groups. Histological examination showed

pyelonephritis in the males 0.2 and 0.4 percent, and doubtfully at 0.4 percent in the females. Thyroid hyperplasia was noted in males at 0.4 percent (Wilson and DeEds, 1959).

Groups of 10 male rats were fed 0, 62, 125, 250, 500, 1000 or 2000 ppm ethoxyquin in the diet. Similarly, groups of 10 females were fed 0, 500, 1000 or 2000 ppm, and groups of five females 125 or 250 ppm. Half the animals in some of the groups of 10 were autopsied after 200 days on the diet. Body-weight gain was depressed in both sexes at 2000 ppm. At autopsy, kidney to body-weight ratio was elevated in the males at 250 ppm and above, and in the females at 2000 ppm. Liver to body-weight ratios were elevated at 1000 and 2000 ppm in males, and at 2000 ppm in females, Wilson and DeEds, 1959). Histopathological examination showed kidney lesions at 500 ppm and above in the males, and at 2000 ppm in the females; inclusions were observed in liver cell cytoplasm in males at 2000 ppm, and in females at 2000 ppm (Cox, 1953).

Long-term studies

Dog

Ethoxyquin was fed to two groups of 14 dogs of mixed sex, at dietary levels of 0 or 300 ppm for five years. No effects were observed on haematology, urinalysis, clinical chemistry (aerum glutamic-oxalic transaminase, blood urea nitrogen and bromosulphthalein retention), organ weights or organ to body-weight ratios, body-weight and gross- or histopathology (Monsanto, 1966).

Rat

Groups, each of approximately 10 male and 10 female rats, were fed levels of 0, 62, 125, 250, 500, 1000, 2000 and 4000 ppm of ethoxyquin in their diets for periods of up to two years. The animals were sacrificed for autopsy after 200, 400, 600 or 715 days. Mortality rates at all dose levels were not significantly different from the controls. Reduced body-weight gain was significant at 2000 ppm after 225 days in the male animals and after 21 days in the females. After 200 days increased liver to body-weight and increased kidney to

body-weight ratios were found at 250 ppm in the males and at 1000 ppm in the females. Haemoglobin values for both sexes were normal 100 and 300 days after the start of the experiment in those rats fed 2000 and 4000 ppm. Histological changes in the renal cortex were clearly evident after 200 days in the male rats receiving 2000 and 4000 ppm, but not in the females. All other organs were normal in both sexes after 200 days. After 400 days lesions in the kidneys (pyelonephritis), liver and thyroid were clearly evident in the males only. Similar lesions were evident for periods up to 717 days in both sexes, although more marked in the males, and occasional tumours were evident after 700 days but were unrelated to the dose-level, and were also evident in the controls. No clearly defined effects were evident from feeding 62 ppm, but minute lesions were present in the kidneys of two of the males receiving the 500 ppm diet. It appeared difficult to distinguish the abnormalities in the group examined after 700 days with pathological manifestations associated with senility after that time (Wilson and DeEds, 1959).

OBSERVATION IN MAN

In 20-years experience in the production of ethoxyquin there was no indication of any cases of skin irritation or sensitivity (Kelly, 1960). However, cases of apparent sensitivity to ethoxyquin have been reported in fruit handlers. Multiple cases of dermatitis have occurred among employees handling freshly sprayed apples moist with solutions of 70 percent formulated ethoxyquin. Patch-testing in volunteers indicated that these skin reactions were not due to direct irritation, but were the result of sensitization (Wood, 1965).

COMMENT

Studies in the rat and the dog indicate that toxic effects upon the liver and kidney occur when dietary levels of 250 ppm and above are given to the rat and 10 mg/kg or higher daily doses are given to dogs. Administration of 300 ppm in the diet, however, was well tolerated by dogs over a five-year period. There was an increase in the number of stillbirths and a decrease in the litter size and in the incidence of survival-to-weaning in rats fed 1125 ppm but not in those fed 125 ppm.

Lower doses (ca. 50 ppm) are rapidly excreted in the rat, dog and chicken. Ethoxyquin is apparently converted to water soluble metabolites and as long as these conversion mechanisms are functioning there appears little likelihood of storage of the compound in the body fat.

The occurrence of dermatitis among fruit packers suggests that sensitization could be a problem among those who are handling ethoxyquin.

TOXICOLOGICAL EVALUATION

Level causing no toxicological effect

Dog: 300 ppm in diet, equivalent to 7.5 mg/kg body-weight/day

Rat: 125 ppm in diet, equivalent to 6.25 mg/kg body-weight/day

ESTIMATE OF ACCEPTABLE DAILY INTAKE FOR MAN

0 - 0.06 mg/kg body-weight

RESIDUES IN FOOD AND THEIR EVALUATION

USE PATTERN

Pre-harvest treatments

Ethoxyquin is used as a pre-harvest treatment for the control of scald of susceptible apple varieties. It is applied once as a full cover spray within two days of harvest at a dosage rate of 3 pints of a commercial formulation containing 70 percent active ingredient per 100 gallons of water (2700 ppm active ingredient).

Post-harvest treatments

For a post-harvest treatment of apples and pears, ethoxyquin is used as a 15-30 sec. dip or a 15 sec. spray prior to or as the fruit passes over the grading line. The dosage rate used is 2 to 3 pints of a commercial formulation containing 70 percent active ingredient per 100 gallons of water (1800-2700 ppm active ingredient). The fruit is treated no later than one week after harvest.

The above information on use patterns was obtained from product labels from Canada, United States, United Kingdom and Italy.

Other uses

Ethoxyquin is also used as an antioxidant in spices, fish meal, poultry feeds, swine feeds and other animal feeds.

Other information pertinent to use pattern

This monograph is confined to information pertaining to only the pesticidal uses of ethoxyquin on apples and pears.

Ethoxyquin manufactured in the United States is sold in the following countries: Sweden, Norway, Denmark, United Kingdom, Netherlands, Belgium-Luxembourg, France, W. Germany, Austria, Switzerland, Finland, Spain, Italy, Rep. of South Africa, Mexico, Colombia, Venezuela, Peru, Chile, Brazil, Philippines, Australia, New Zealand, United States and Canada (Monsanto - Direct communication, 1969).

Information concerning uses in countries other than Canada, United States, United Kingdom and Italy, such as Israel, Japan, West Germany and Sweden, where it was understood that ethoxyquin was manufactured, was not available to the Joint Meeting.

RESIDUES RESULTING FROM SUPERVISED TRIALS

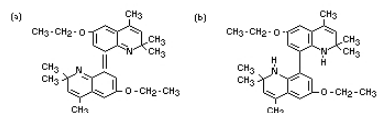
The results reported in Tables 1, 2, 3 for apples and 6 and 7 for pears are from supervised trials made in various geographical locations in the United States (Monsanto, 1961). Those in Tables 4 and 5 for apples, are from supervised trials carried out in New Zealand (Padfield et al., 1963).

Summary of residue data

The residues of ethoxyquin on apples and pears when applied as a dip or spray on a whole-fruit basis did not exceed 1.2 ppm from U.S.A. data. However, from New Zealand, levels up to 2.8 ppm on apples have been reported and one variety, Dougherty, which appears to have the ability to retain fairly high levels of residue, was reported to have levels up to 4.4 ppm. Results obtained in New Zealand also indicate that use of a warm dip may result in residues of ethoxyquin on apples as high as 6 ppm. Experimental results suggest that the uptake of ethoxyquin is likely to increase as apple fruit matures and cooled fruit appears to show lower residues than fruit treated at normal air temperature. The results of trials carried out in the United States indicate that residues found as a result of spraying fruit on the tree are generally less than when apples or pears are dipped post-harvest.

FATE OF RESIDUES

Ethoxyquin, instead of existing as a single molecule, changes spontaneously into a complex resulting from oxidation. These complex structures are still effective biologically. No major degradation change occurs in the ethoxyquin molecule. The structure of the oxidation product has not been definitely determined but the structures of the first reaction product(s) which fit the observations most closely are suggested to be:



(Monsanto, 1958)

TABLE 1

Pre-harvest treatments - applied as a fruit and foliage spray just prior to picking of apples.

Treatment Rate (ppm ethoxyquin)	Apple Variety	Interval between Treatment and Sampling (days)	Residue (ppm)	
			Fresh Apples	Stored Apples
900	Paragon Winesap	13 - 14	0 - 0.2	
1800	"	13 - 14	0.03 - 0.35	
1500	McIntosh	23 - 24 44	0 - 0.01	0 - 0.11
3000	McIntosh	23	0	0 - 0.16
2000	Wealthy	53		0.01 - 0.10
0	Greening	53		0.00 - 0.11
2000	"	22 53	0.00 - 0.13	0.01 - 0.11
2000	McIntosh	20 51	0.00 - 0.01	0.00

TABLE 2

Post-harvest treatments - using a 15 second dip or applied as a spray.

Treatment Rate (ppm ethoxyquin)	Apple Variety	Interval between Treatment and Sampling (days)	Residue (ppm)	
			Fresh Apples	Stored Apples
1000	Red Delicious	2 31	0.07, 0.42	0.13, 0.07
2000	"	3 32	0.20, 0.34	0.14, 1.17
3000	"	3 32	0.48, 0.34	0.53, 1.00

1000	Jonathon	4 32	0.03, 0.18	0.11
2000	"	4 33	0.62, 0.43	0.04, 0.04
3000	"	4 33	0.44, 0.81	0.09 0.04
2000	Wealthy	23 55	0.00 - 0.62	0.00 - 0.20
3000	"	23 55	0.01 - 0.81	0.04 - 0.14
0	Greening	50		0.00 - 0.11
2000	"	20 50	0.03 - 0.13	0.00
2000	McIntosh	19 49	0.00	0.00

TABLE 3

Post-harvest treatments - using a 15 second dip.

Treatment Rate (ppm ethoxyquin)	Apple Variety	Interval (days)*	Peel	Residues (ppm) Pulp	Whole Apple
0	Jonathon	1	0.2 - 0.3		0.03 - 0.04
1000	"	1	3.6 - 4.1		0.47 - 0.54
2000	"	1	4.5 - 4.7		0.61 - 0.64
3000	"	1	5.4 - 5.7		0.67 - 0.70
4000	"	1	8.0 - 7.5		0.94 - 1.00
0	McIntosh	7	0.07, 0.11	0.08, 0.11	0.08, 0.11
3600	"	7	1.45, 1.45	0.14, 0.14	0.29, 0.30
0	Cortland	7	0.07, 0.16	0.07, 0.09	0.08, 0.08
2700	"	7	1.75, 1.80	0.07, 0.11	0.30, 0.32

* Interval between treatment and sampling

TABLE 4

Residues on apples dipped or sprayed with 1800 ppm ethoxyquin.
The samples of fruit for analysis were withdrawn from the
line during normal operation and residue determinations were
made as soon as possible after treatment.

Apple Variety	Treatment	Residue (ppm)	
		First Pick March-April	Second Pick March-May
Delicious	Cool dip	1.4	1.2
	Warm dip	1.5	1.9
	Spray	1.0	0.8
Granny Smith	Cool dip	1.1	2.8
	Warm dip	1.6	4.8
	Spray	1.5	0.7
Rome Beauty	Cool dip	0.7	1.4
	Warm dip	2.4	1.8
	Spray	0.9	1.3
Sturmer	Cool dip	0.5	1.6
	Warm dip	1.8	2.7
	Spray	1.8	2.3
Dougherty	Cool dip	2.6	4.4
	Warm dip	1.9	6.0
	Spray	2.2	3.0

TABLE 5

Ethoxyquin residues on apples after treatment in commercial spay tunnels.
Residue analyses were made as soon as possible after treatment.

Treatment Rate (ppm ethoxyquin)	Apple Variety	Fruit Temperature	Residue (ppm)
1800	Sturmer	Air temp. Cooled 38°F	1.6 0.7
1800	Granny Smith	Air temp. Cooled 33°F	0.7 - 1.7 0.5 - 1.0
2700		Air temp. Cooled 33°F	2.2 1.5

TABLE 6

Pre-harvest treatments – applied on a fruit and foliage spray just prior to picking of pears.

Treatment Rate (ppm ethoxyquin)	Pear Variety	Interval between Treatment and Sampling (days)	Residues (ppm)	
			Fresh Fruit	Stored Fruit
1000	Anjou	23 – 25 70 – 71	0.01	0.00
2000	"	23 – 25 70 – 71	0.01 – 0.04	0.00

TABLE 7

Post-harvest treatments using a 15 second dip.

Treatment Rate (ppm ethoxyquin)	Pear Variety	Interval (days)*	Residues (ppm)			
			Pulp	Peel	Whole Fruit	Stored Fruit
900	Anjou	53				0.00
1800	"	53				0.00
1000	"	53				0.03
1500	"	53				0.03
2000	"	53				0.01
2700	"	7	0.04 – 0.05	4.7 – 4.9	0.66	
3600	"	7	0.04 – 0.09	7.6 – 8.3	1.09	
5400	"	7	0.04 – 0.08	7.9 – 9.2	1.07	

* Interval between treatment and sampling.

Evidence of residues in food in commerce or at consumption

No information available.

METHODS OF RESIDUE ANALYSIS

Methods using ultraviolet spectrophotometry or spectrofluorometry have been proposed for the determination of residues of ethoxyquin in food, feed and animal tissue. The spectrophotometric methods of Choy et al. (1963) and Alicino et al. (1963) both include clean-up stages to separate ethoxyquin from other anti-oxidants such as butylated hydroxyanisole and butylated hydroxytoluene before estimation of absorbance at 296 nm. A spectrofluorometric procedure for ethoxyquin in feeding stuffs (Gordon et al., 1964) was adapted for use on samples of eggs, chicken muscle and liver (Van Deren and Jaworski, 1966). It is relatively non-specific for ethoxyquin and residues of other pesticides or of other naturally occurring compounds may interfere. Collaborative study of this method (Van Deren and Jaworski, 1967) led to its adoption as an official, first action procedure (Anon, 1968). The ethoxyquin is extracted with iso-octane, cleaned-up by an acid-alkaline extraction procedure and determined by examining the fluorescence of an iso-octane solution. The suitability of this method for application to fruit for regulatory purposes needs further evaluation.

NATIONAL TOLERANCES

Tolerances for Fruit

Canada – 3 ppm on apples

U.K. – 3 ppm on apples

U.S.A. – 3 ppm on apples and pears
(for ethoxyquin and other naturally occurring
fluorescent materials).

New Zealand – 3 ppm on apples

Tolerances derived from use as additives in animal feeds

Canada – 3 ppm in livers of poultry
0.5 ppm in meat, poultry meat and eggs

U.S.A. – 3 ppm in poultry livers and fat
0.5 ppm in eggs and meat

APPRAISAL

In a review of the literature very few articles were found on ethoxyquin other than those on its efficacy in controlling scald. The abstracting journals reviewed were, Review of Applied Mycology, Biological Abstracts, Chemical Abstracts and Pesticide Documentation Bulletin.

Data available are based on ethoxyquin as manufactured in the U.S.A. and used in several other countries. Ethoxyquin is also manufactured in Israel, Japan, West Germany and Sweden. The amount and nature of minor constituents and amount of ethoxyquin monomer in products other than U.S.A. manufacture is unknown. It is used for the control of scald in apples (and to a lesser extent pears), as both pre-harvest treatments and post-harvest dips and sprays.

The residues of ethoxyquin on apples and pears when applied as a dip or spray on a whole-fruit basis did not exceed 1.2 ppm from U.S.A. data. However, from New Zealand, levels up to 2.8 ppm on apples have been reported and one variety, Dougherty, which appears to have the ability to retain fairly high residue, was reported to have levels up to 4.4 ppm. Results obtained in New Zealand also indicate that use of a warm dip may result in residues of ethoxyquin on apples as high as 6 ppm. Experimental results suggest that the uptake of ethoxyquin is likely to increase as apple fruit matures. Cooled fruit appears to have lower residues than fruit treated at normal air temperature. The results of trials carried out in the U.S.A. indicate that residues found as a result of spraying fruit on the tree are generally less than when apples or pears are dipped post-harvest.

Ethoxyquin, instead of existing as a single molecule, changes spontaneously into a complex resulting from oxidation. These complex structures are still effective biologically. No major degradation change occurs in the ethoxyquin molecule. The structure of the oxidation product has not been definitely determined, but the structures of the first reaction product(s) which fit the observations most closely are given in the monograph.

The fluorometric method is relatively non-specific for ethoxyquin on apples and pears. Many naturally occurring fluorescent materials may interfere. It is also possible that residues of other pesticides used on apples may fluoresce or be converted into fluorescent compounds. More suitable spectrofluorometric methods available for animal products should be adopted and evaluated.

RECOMMENDATIONS FOR TOLERANCES, TEMPORARY TOLERANCES OR PRACTICAL RESIDUE LIMITS

TOLERANCES

Apples and pears 3.0 ppm

DESIRABLE

1. Additional reproduction studies to investigate the effect on survival rate of offspring of rats.
2. A method of analysis for apples and pears suitable for regulatory purposes.
3. Composition and purity of this compound as manufactured in several countries and the amount of ethoxyquin monomer in the products from various manufacturers.

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See Also:

[Toxicological Abbreviations](#)

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