SOYBEAN OIL MEAL AS A FACTOR IN RESISTANCE OF CHICKENS TO PARASITISM

by

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INTRODUCTION

The resistance of animals to parasitism is known to be due to many factors. Those of age, genetic constitution and diet were reviewed recently by Ackert (1942). Vitamins A, B (complex), and D were found by Ackert and his co-workers to be factors in the resistance of chickens to the parasite Ascaridia galli (A. lineata). One study was reported by them on protein supplements as factors in resistance of animals to parasitism. In that study Ackert and Beach (1933) found that chickens whose basal cereal ration was supplemented with peanut meal were less resistant to A. galli than were chickens whose basal cereal ration was supplemented with meat meal and meat meal and skim milk (ad libitum). The results indicated that a diet entirely of plant origin produced the slowest growth rate and the least resistance to the growth of worms in the chickens.

Ascaridia galli is of common occurrence, especially in the central United States, where the incidence may be as high as 49 percent and the average infection 10 worms per chicken (Ackert, 1930). Heavily infected chickens are sluggish, their wings droop and the feathers are ruffled. There is a loss of appetite, the bone and muscular development is retarded, and there is a noticeable loss of weight and body fat (Ackert and Herrick, 1928).

Due to the scarcity of meat and milk supplements in wartime, and the increase in soybean production, it seemed desirable to ascertain if soybean oil meal could be substituted for meat or milk supplements in fowl rations without lowering the resistance of the birds to the nematode A. galli.

REVIEW OF LITERATURE

Soybean oil meal as a protein supplement in rations for chickens has been tested by a number of workers. Review of a few recent papers will give an idea of the current knowledge of this subject. For example, Irwin and Kempster (1942) found that rations containing soybean oil meal up to 25 percent of the total ration produced gains in weight equal to those produced on a ration in which the proteins were supplied from different sources. Carver, Rhian, Bearse, Boucher, Berg, and Miller (1943) found that rations containing 20 percent protein, with soybean oil meal as the only protein supplement, produced gains in net weight as good as rations containing both herring fish meal and soybean meal as protein sources in a ration containing 17.5 percent protein. Most investigators seemed to feel that a combination of proteins from two or more sources is better than protein from one source alone.

A loss of weight occurred in pullets on soybean meal alone, as found by Norris and Heuser (1943), although as many hatchable eggs were produced as when some animal protein was added. They found it was possible to compensate for a shortage of animal protein by increased amounts of soybean meal. On a 20 percent protein diet, Polk and Barnett (1943) found that more economical gains were made on rations containing both animal and vegetable proteins than from either alone. When supplemented with oyster shell flour and steamed bonemeal, soybean oil meal compared favorably with other high protein sources.

Christiansen and his co-workers have done considerable work on supplements for soybean meal in chick rations. They found (1939) that the protein of grains supplemented solely by soybean oil meal proved inefficient and required additional supplementation with other proteins for maximum efficiency. They found too (1940) that dried skim milk was inferior to fish meal as a supplement, but superior to either meat scrap or casein. Various investigators have found different protein supplements to be of greatest value in combinations with soybean oil meal.

Van Landingham, Clark, and Schneider (1942) found that with seven to 18 weeks old chickens the protein utilization of soybean meal was 76 percent as compared with 58 percent for casein, and 41.9 percent for meat scraps. They found that meat scrap and soybean meal showed similar supplementary values.

Most of the work with soybeans as a feed has been done from the standpoint of growth and gains in weight, especially in chickens. The study most closely related to soybean oil meal as a factor in resistance is the work of Ackert and Beach (1933), who found that peanut meal was not as efficient a supplement as meat meal and liquid skim milk in developing resistance of chickens to Ascaridia galli.

MATERIALS AND METHODS

The chickens used in these experiments were obtained as day-old birds from commercial hatcheries, or Kansas State College Poultry Farm, and were raised in confinement helminth-free until parasitized. The weights were recorded each week.

The basal ration for all the chickens was as follows: Yellow corn meal, 39.3 percent (37.9 percent in Group I); ground wheat, 14.3 percent; ground oats, 14.3 percent; bran, 7.1 percent; alfalfa leaf meal, 7.1 percent; calcium carbonate, 2 percent (3 percent in Group III); iodized salt, 0.7 percent; cod liver oil, 1.4 percent; and manganese sulfate, 10 g per 100 pounds. In addition, Group I received meat scrap (45 percent protein), 12.1 percent, and powdered skim milk (32 percent protein), 3.6 percent; Group II received meat scrap, 14.3 percent; Group III received soybean oil meal (43 percent protein), 14.3 percent. Each ration was thoroughly mixed and fed in hoppers, and fresh water was kept before the birds at all times.

The parasite used was the large roundworm (Ascaridia galli) of the chicken. The eggs were removed from the uteri of live worms and cultured to the infective stage in 0.1 percent formalin at a temperature of 32°C. At 37 days of age each chicken was fed 100 ± 10 A. galli eggs on tissue paper. Three weeks later the chickens were killed and the worms collected.

The intestine, from the gizzard to the yolk sac diverticulum was removed from the freshly killed birds and the contents flushed into a fruit jar with hot water by the hydraulic method of Ackert and Nolf (1929). The material thus removed was left for several hours so as to avoid extreme coiling in killing and preserving the worms. A small volume of 10 percent formalin was added to each jar as a preservative. The contents of each jar were emptied into a large moist chamber resting on carbon paper, and examined minutely for the white worms, often with a

binocular microscope. The worms from each fowl were placed in a glass vial in 10 percent formalin until measured.

To reduce error in measurement, the shadow of each worm was magnified six times and thrown on the ground glass of a photographic bellows. Tracings on thin paper were then made of each worm. To determine the actual length, the penciled tracing was followed with a calibrated milled wheel which gave the actual length in millimeters.

Lengths of the worms were used as the criterion for judging the resistance of the groups of chickens to the A. galli.

Experiment 1

Six dozen single comb White Leghorn chicks were separated into three groups by weight, so that each chick in Group I was matched with chicks of equal weight in Groups II and III. To reduce variation, the largest and smallest chicks were excluded. The experimental birds were placed on their respective rations at 23 days of age, and two weeks later, at 37 days of age, each fowl was parasitized with approximately 100 infective eggs of the nematode Ascaridia galli. Three weeks later, at 58 days of age, they were killed and the nematodes removed for measuring.

The chickens in Group I (meat scrap and milk supplement) had an average of 14.2 worms, those in Group II (meat scrap supplement) had 14.2 worms, and those in Group III (soybean oil meal supplement) had only 10.1 worms on an average. The worms in Group I averaged 23.2 mm in length, those in Group II averaged 23.5 mm, and those in Group III, 22.1 mm. There were fewer

worms in the Group III chickens, but the length was approximately the same (Table 1).

The chickens in Group I made the best gains in weight and those in Group III made slightly the poorest. The growth curves for all three groups followed the pattern of the established normal (Card and Kirkpatrick, 1918), although each of the experimental groups averaged less than normal (Fig. 1).

In Group I the heaviest bird had an average number of worms, and the lightest one had the heaviest infection. In Group II the heaviest bird had more worms than the lightest, but both had fewer than average; the heaviest infection was in a bird slightly above average weight. In Group III the lightest bird had no worms and the heaviest had only one; the heaviest infection was again in a bird of about average weight.

The results of this test indicated that soybean oil meal as a supplement was as effective as meat scrap or meat scrap and milk supplement in developing resistance in the chickens to the growth of the worms.

Experiment 2

The same number of chicks were separated into three equal groups by weight and placed on their respective rations at six days of age. They were parasitized at 37 days of age, and 18 days later, at 65 days of age, the chickens were killed and the nematodes removed for examination.

The chickens in Group I had an average of 4.0 worms, those in Group II had 6.5, and those in Group III had 4.2 worms. The

Table 1. Comparison of chicken weights and worm lengths in Groups I, II and III, Experiment 1.

Group I. Meat scraps and milk					Group II. Meat scraps					Group III. Soybean oil meal				
Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms	
	Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)
1926	134	515	1	20.0	1958	134	520	18	21.3	1925	140	536	7	19.4
1920	130	565	23	23.9	1931	130	508	2	14.4	1932	130	608	1	25.0
1907	130	506	9	23.6	1910	128	532	13	23.4	1935	126	580	7	20.9
1956	126	560	6	25.8	1969	126	504	0	0.0	1908	126	525	7	20.8
1922	126	580	27	21.7	1912	124	534	6	23.0	1924	124	463	1	4.2
1940	124	504	15	20.57	1916	122	553	12	21.5	1928	122	466	1	3.1
1906	120	506	22	24.2	1923	120	500	24	27.5	1911	118	460	11	21.6
1914	116	606	21	27.9	1919	116	472	22	20.0	1965	116	480	0	0.0
1968	114	512	15	22.5	1921	114	484	13	26.1	1938	114	438	12	21.9
1942	112	614	0	0.0	1901	110	435	10	25.2	1918	110	436	0	0.0
					1933	110	435	18	23.0	1934	110	513	13	22.8
1945	110	616	14	19.45	1948	110	460	28	22.6	1952	110	494	13	21.1
1947	108	486	2	28.0	1915	104	498	37	24.1	1937	106	504	2	13.05
1950	104	446	5	25.5	1914	102	615	9	20.8	1964	102	364	15	17.6
1936	102	415	21	19.85	1902	100	432	12	23.4					
1960	100	477	8	19.2	1961	100	432	2	10.9	1953	100	408	13	19.0
1957	94	385	12	21.4	1917	92	395	7	17.0	1905	94	340	21	15.9
					1939	90	340	18	23.0	1914	90	332	30	20.7
1951	90	402	33	27.8	1962	86	330	4	20.3	1949	86	443	48	29.8
1943	86	395	2	6.45	1955	84	418	21	26.7	1913	82	390	0	0.0
1909	78	356	33	22.3	1959	80	325	23	26.1	1930	80	330	0	0.0
Average	109.81	497.1	14.2	23.2	Average	108.67	462.9	14.2	23.5	Average	108.67	455.5	10.1	22.1

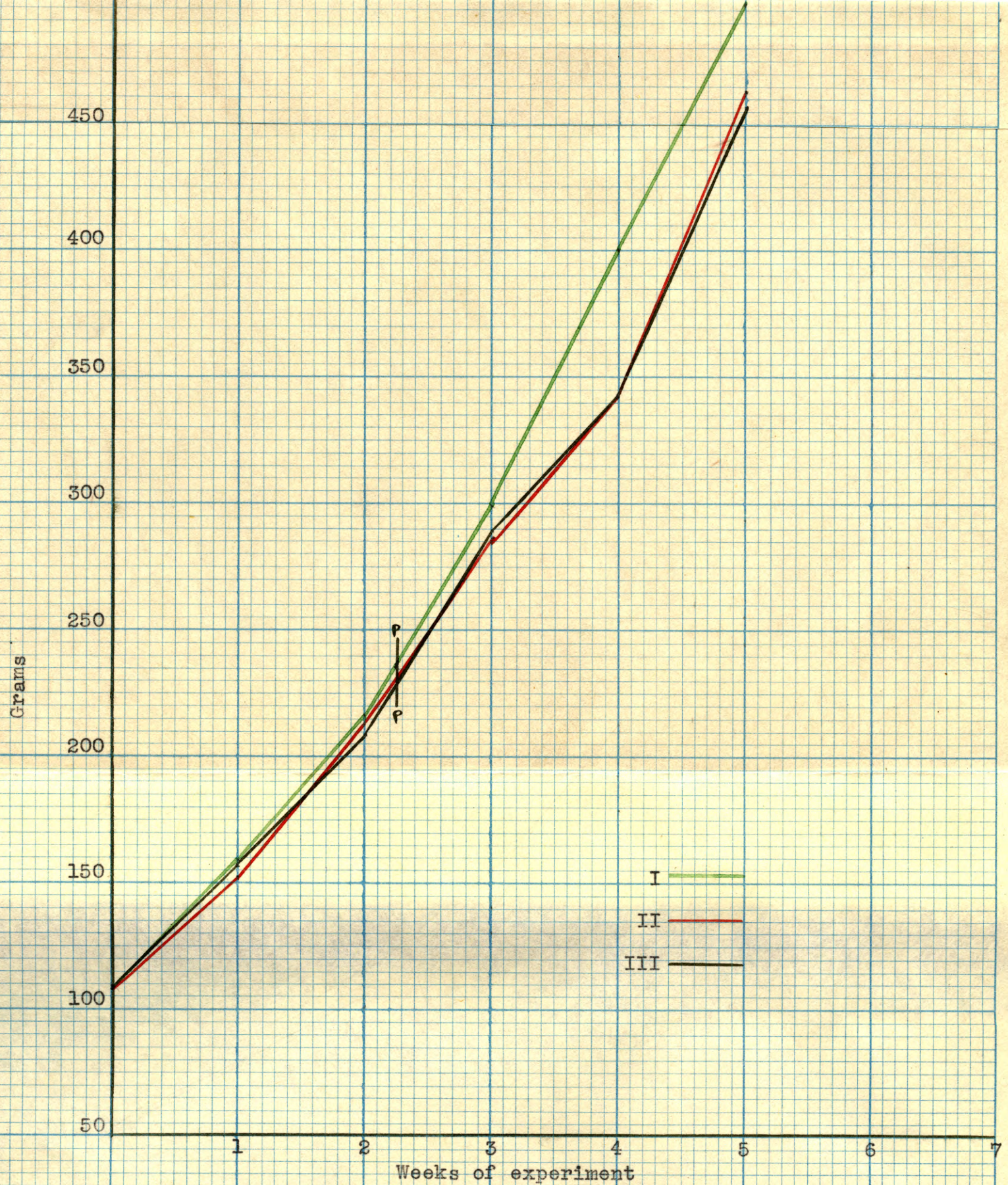

Fig. 1. Average weights of chickens in Groups I, II and III, Experiment 1. Chicks 23 days old at start of experiment. P indicates age at which the chickens were parasitized.

worms in Group I averaged 20.5 mm in length, those in Group II averaged 18.5 mm, and those in Group III averaged 20.5 mm. There were a few more worms in Group II, although these worms were slightly shorter (Table 2). The amount of variation indicated that the difference in length was within the range of experimental error.

The chickens in Group III made the best gains in weight, being slightly above the normal, while those in Group II made slightly the poorest (Fig. 2).

In Group I the heaviest bird had slightly more than the average number of worms, while the lightest bird had no worms at all; the heaviest infections were in birds slightly and about 25 percent below average weight. In Group II the heaviest bird had two more worms than the lightest bird, both being about average infections; the heaviest infection occurred in a bird slightly above average weight. In Group III the heaviest bird had about an average infection, while the lightest fowl had no worms; the heaviest infection occurred in a chicken of about average weight.

The data tend to show that soybean oil meal was as effective as the meat scraps or the meat scraps and milk supplement in maintaining the resistance of the chicken to the growth of the worm.

Experiment 3

In Experiment 3, the chicks were matched by weight into three groups of 24 each and placed on their respective rations

Table 2. Comparison of chicken weights and worm lengths in Groups I, II and III, Experiment 2.

Group I. Meat scraps and milk					Group II. Meat scraps					Group III. Soybean oil meal				
Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms	
	Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)
1991	64	562	3	27.0	2005	64	430	2	11.5	2024	64	706	5	19.0
					2034	64	524	0	0.0	2037	64	556	3	24.8
2002	62	542	0	0.0	1986	60	548	2	19.5	2007	62	642	6	20.3
1988	60	612	6	17.3	2000	60	518	3	16.8	2013	60	406	5	16.5
2016	60	420	10	20.5	2023	60	440	10	17.3	2031	60	486	10	22.0
2010	58	406	2	22.9	2022	58	556	7	17.3	1978	58	588	0	0.0
2009	56	410	4	20.4	2011	56	504	9	21.2	2026	56	632	0	0.0
2021	54	368	2	21.8	2027	54	458	10	21.0	2036	54	602	3	21.0
2038	54	428	5	19.4	2041	56	452	18	18.3	2039	54	468	8	25.4
					2019	52	320	4	17.6	2025	52	536	1	23.5
1977	53	536	0	0.0	1984	53	370	8	20.9	1985	53	436	0	0.0
1973	51	500	5	22.8	1974	50	374	5	14.1	1975	52	382	3	20.2
1992	50	440	6	20.8	1996	50	436	10	16.8	2006	50	512	6	25.6
					2014	50	392	5	18.1	2020	50	474	6	22.1
1971	48	430	8	18.2	1980	48	398	8	21.9	1994	48	436	1	22.3
2003	48	460	6	19.7	2004	48	452	1	20.5	2028	48	346	2	16.4
1970	47	398	1	12.0	1989	47	348	10	17.9	1999	47	362	8	19.5
1670	48	408	1	17.5	2032	50	238	5	20.3	2035	50	696	9	19.9
1972	45	340	7	23.9	1979	45	402	5	24.8	1982	45	220	0	0.0
1995	45	320	0	0.0	1997	45	402	4	15.2	2033	45	357	7	10.2
1981	44	436	1	20.0	1993	44	338	8	17.4	2001	44	624	3	18.1
2008	44	360	4	14.6	2015	44	464	14	19.4	1990	44	340	6	18.3
1671	43	346	10	22.7	1987	43	428	0	0.0					
Average	52.17	436.1	4	20.5	Average	52.22	425.7	6.5	18.5	Average	52.3	491.2	4.2	20.5

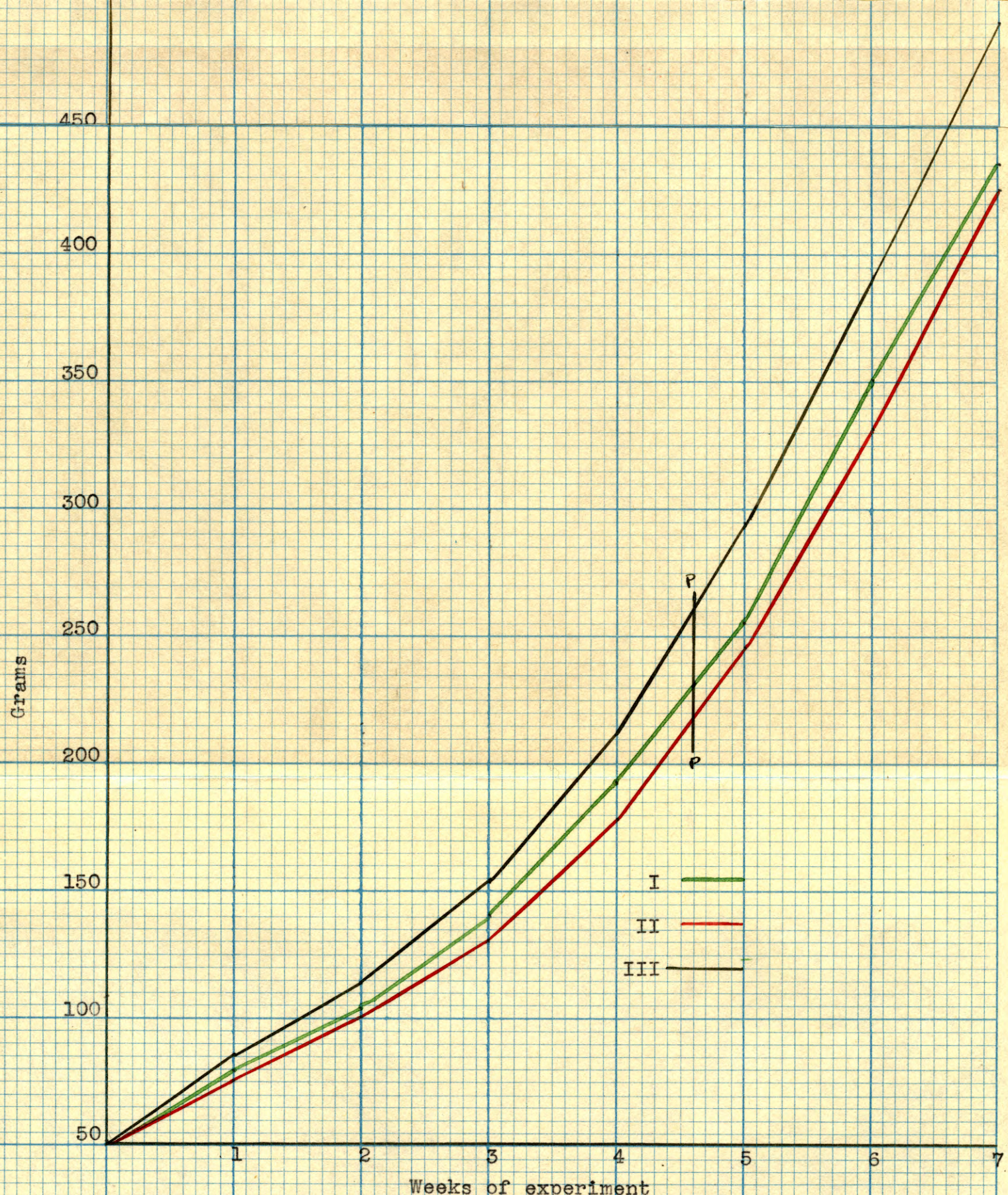

Fig. 2. Average weights of chickens in Groups I, II and III, Experiment 2. Chicks six days old at start of experiment. P indicates age at which the chickens were parasitized.

at nine days of age. They were parasitized at 37 days of age, and 22 days later, when they were 59 days old, they were killed and the nematodes removed for examination.

Although about 100 embryonated eggs had been given to each bird, the chickens in Group I had an average of only 3.2 worms, those in Group II had 3.0, and those in Group III had 2.1 worms. The worms in Group I averaged 21.5 mm in length, those in Group II averaged 18.2 mm, and the worms in Group III averaged 19.7 mm. Group I had slightly the most and the longest worms, while Group III had the fewest and Group II the shortest (Table 3).

The chickens in all three groups made about the same gains in weight and were about normal, with those in Group II trailing only slightly (Fig. 3).

In Group I the heaviest bird had more than three times the average number of worms, while the lightest bird had more than twice the average. The heaviest infection was in a bird more than 20 percent below average. In Group II the heaviest and lightest birds had no worms, the heaviest infection being in a bird nearly 15 percent above average weight. In Group II the heaviest chicken had no worms and the lightest had one worm; the heaviest infection occurred in a bird of about average weight.

The indication from this test is that soybean oil meal was nearly as effective as meat scraps and more so than the meat scraps and milk supplement in maintaining the resistance of the chickens to the growth of the worms.

Table 3. Comparison of chicken weights and worm lengths in Groups I, II and III, Experiment 3.

Group I. Meat scraps and milk					Group II. Meat scraps					Group III. Soybean oil meal				
Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms	
	Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)
2064	70	572	1	6.6	2055	72	510	0	0.0	2076	68	675	0	0.0
2059	67	544	4	17.5	2084	68	507	2	22.0	2107	66	510	0	0.0
2106	66	537	11	18.5	2079	66	578	12	16.7	2069	66	508	12	19.9
2061	66	501	0	0.0	2045	65	365	2	18.4	2056	66	545	2	7.8
2072	64	476	0	0.0	2070	64	493	0	0.0	2048	65	463	2	17.2
2073	64	587	2	14.8	2085	64	537	0	0.0	2099	64	485	6	22.6
2052	62	533	0	0.0	2049	62	583	1	18.5	2100	64	585	0	0.0
2054	62	435	6	21.8	2063	62	557	5	14.5	2067	62	539	6	26.3
2051	60	658	11	24.0	2092	62	482	0	0.0	2086	62	587	1	4.5
2058	60	454	1	4.2	2060	60	549	3	4.8	2062	60	445	0	0.0
2083	60	487	0	0.0	2081	60	502	0	0.0	2075	60	486	0	0.0
2087	60	647	1	28.9	2088	60	490	0	0.0	2093	60	475	2	9.0
2101	60	556	1	23.3	2096	60	508	2	28.8	2095	60	665	7	24.1
2102	60	339	8	18.8	2104	60	500	1	30.2	2109	60	616	0	0.0
2053	58	512	0	0.0	2044	58	478	2	25.1	2112	60	579	0	0.0
2068	58	489	0	0.0	2071	58	502	0	0.0	2074	58	490	0	0.0
2108	58	384	21	25.7	2080	58	607	0	0.0	2078	58	436	0	0.0
2113	58	573	1	9.0	2047	56	482	9	24.7	2050	56	500	6	16.6
2077	56	497	0	0.0	2065	56	538	6	11.3	2057	56	270	1	5.0
2082	56	494	0	0.0	2089	56	570	18	18.4	2098	56	506	0	0.0
2090	54	450	0	0.0	2046	54	365	0	0.0	2115	54	452	0	0.0
Average	60.9	515.5	3.2	21.5	Average	61.0	209.7	3	18.2	Average	61.0	515.1	2.1	19.7

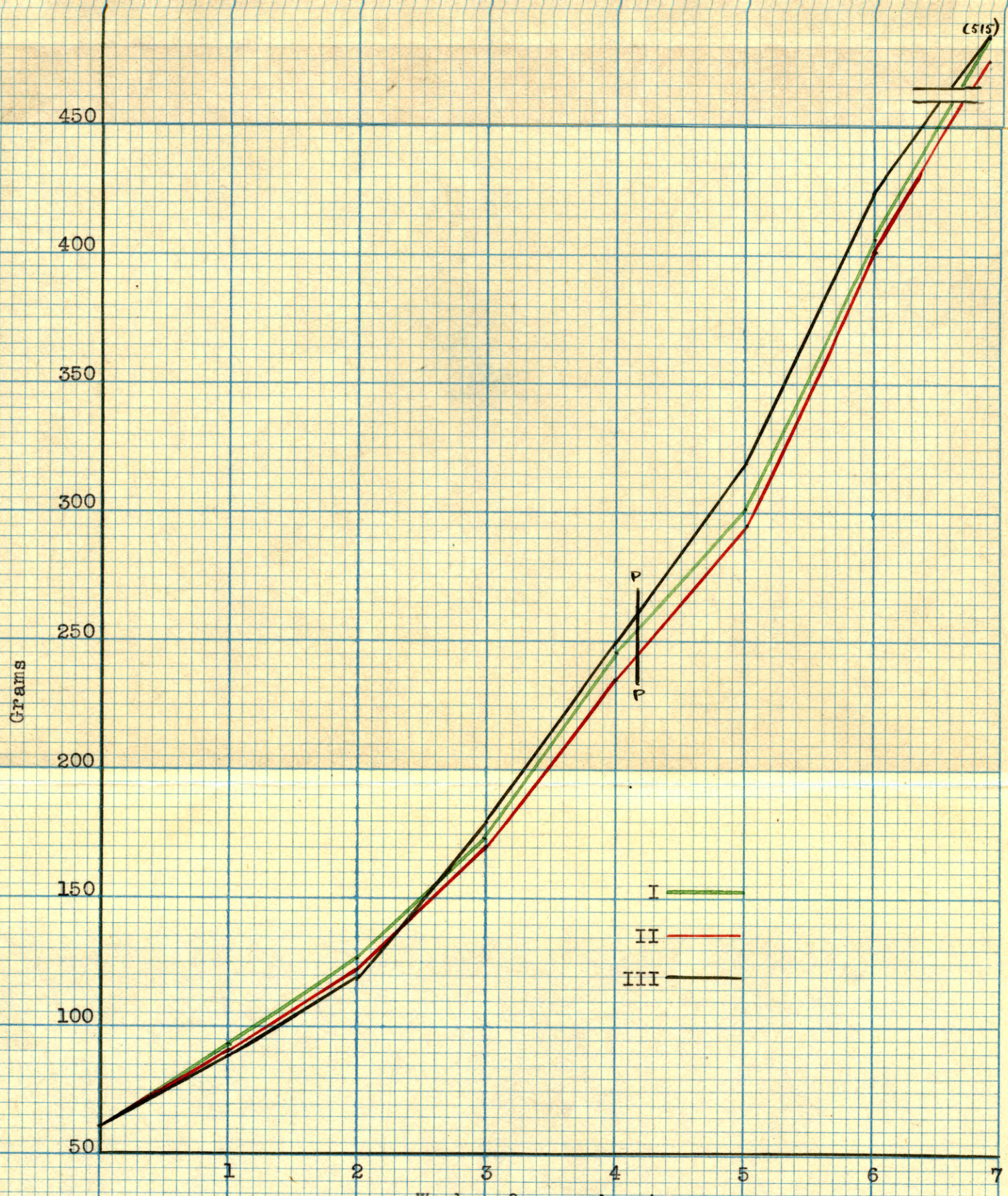

Fig. 3. Average weights of chickens in Groups I, II and III, Experiment 3. Chicks nine days old at start of experiment. P indicates age at which the chickens were parasitized.

Experiment 4

The six dozen chicks used in this experiment were separated into equal groups by weight and placed on their respective rations at 12 days of age. They were parasitized at 38 days of age, and 20 days later, at 58 days of age, they were killed and the nematodes removed for examination.

The chickens in Group I had an average of 2.4 worms, those in Group II had 4.5, and those in Group III had 3.4 worms. The worms in Group I averaged 20.5 mm in length, those in Group II averaged 23.9 mm, and those in Group III averaged 21.1 mm. The most and longest worms were in Group II, while the fewest and shortest were in Group I (Table 4).

The chickens in Group III made the best gains in weight and those in Group II made the poorest; all three groups were above normal weight (Fig. 4).

In Group I the heaviest bird had one worm, the lightest bird, none; the heaviest infection occurred in a bird slightly above average weight. In Group II the heaviest and lightest birds had no worms; the heaviest infection occurred in birds about 10 percent above and slightly below average weight. In Group III the heaviest bird had a less than average infection, while the lightest bird had about average. The most worms were found in a bird about 15 percent below average weight.

The results of this test indicated that soybean oil meal was more effective than meat scraps alone as a supplement, but not quite as effective as meat scraps and milk in maintaining the resistance of the chicken to the growth of the worms.

Table 4. Comparison of chicken weights and worm lengths in Groups I, II and III, Experiment 4.

Group I. Meat scraps and milk					Group II. Meat scraps					Group III. Soybean oil meal				
Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms	
	Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)
2140	80	510	0	0.0	2161	78	528	0	0.0	2134	78	534	3	15.0
2171	77	462	0	0.0	2132	75	576	0	0.0	2154	75	480	13	21.0
2135	74	532	0	0.0	2169	74	516	17	31.9	2152	75	560	0	0.0
2138	72	490	0	0.0	2141	72	486	0	0.0	2145	72	590	0	0.0
2172	72	612	1	3.5	2158	72	572	3	7.3	2148	72	552	2	19.3
					2130	72	550	4	17.9	2150	70	522	10	20.6
2155	70	498	10	20.0	2162	70	394	0	0.0	2163	70	452	4	16.1
2136	68	390	2	24.1	2127	70	482	1	21.2	2131	70	622	2	20.0
2139	68	342	0	0.0	2133	68	480	1	13.5	2143	68	440	2	13.1
2126	68	524	16	23.0	2188	67	470	0	0.0	2133	67	562	2	8.1
2189	66	460	8	24.2	2180	66	438	18	26.4	2168	66	520	0	0.0
					2144	66	448	4	16.5	2156	66	504	12	23.5
2166	64	484	2	12.0	2170	64	468	0	0.0	2190	64	522	0	0.0
					2121	64	520	7	13.6	2175	63	366	3	9.4
2160	62	442	1	20.8	2167	62	270	0	0.0	2179	63	456	0	0.0
2125	62	522	1	10.0	2151	62	440	4	25.6	2157	62	390	0	0.0
2178	60	590	0	0.0	2181	60	414	0	0.0	2183	60	394	0	0.0
2164	60	482	0	0.0	2165	60	438	5	25.0	2176	60	570	1	11.5
2137	60	416	0	0.0	2153	60	444	4	19.0	2159	60	520	0	0.0
2118	60	578	0	0.0	2119	60	490	0	0.0	2142	60	450	0	0.0
					2184	58	428	20	18.5	2149	59	420	21	26.5
					2116	58	510	11	27.3	2128	58	554	0	0.0
Average	66.3	484.4	2.4	20.5	Average	66.3	466.5	4.5	23.9	Average	66.3	499.1	3.4	21.1

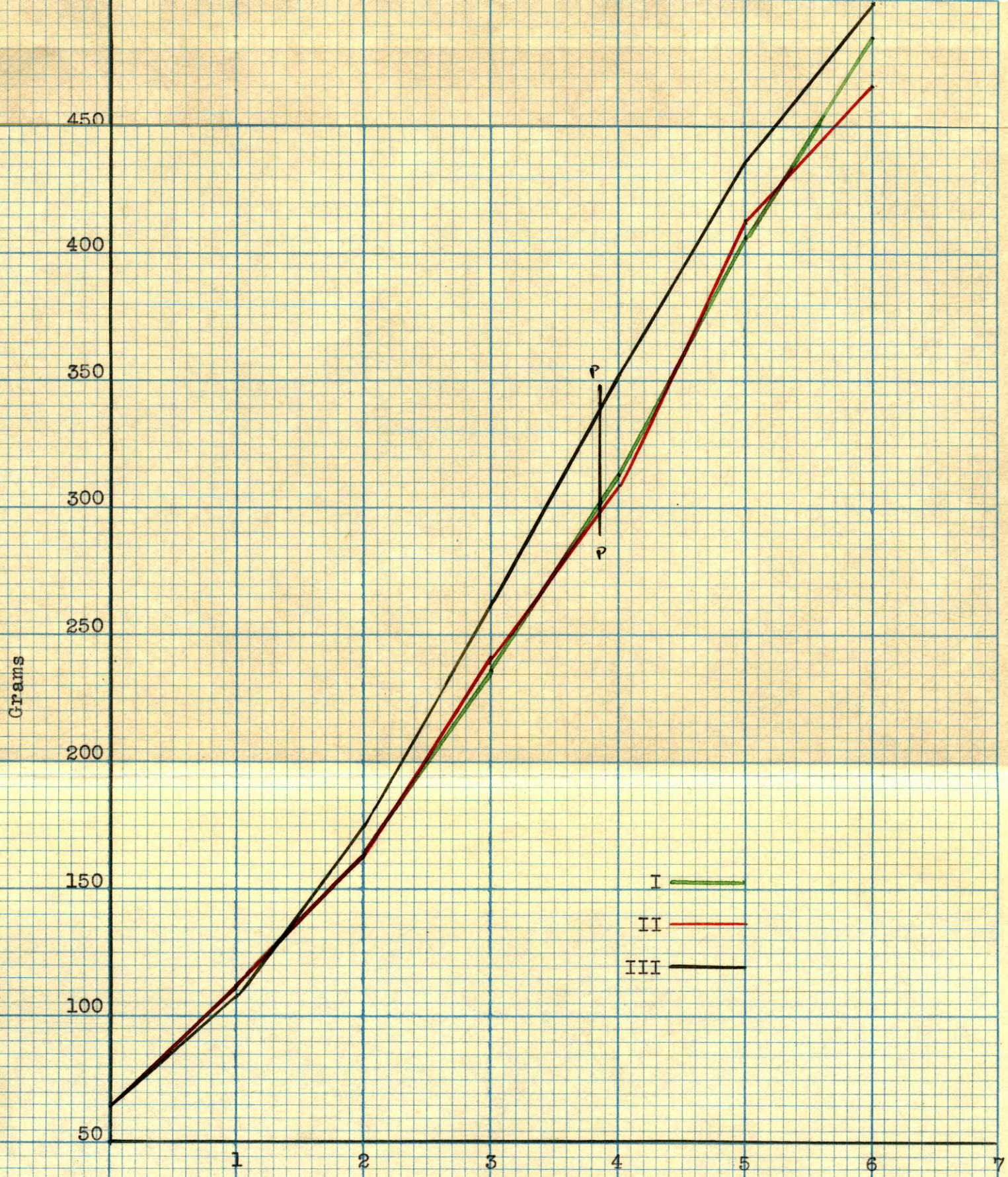

Fig. 4. Average weights of chickens in Groups I, II and III, Experiment 4. Chicks 12 days old at start of experiment. P indicates age at which the chickens were parasitized.

Experiment 5

In the last test of this series, the 72 chicks were separated into three equal groups by weight and placed on their respective rations at 15 days of age. They were parasitized when 36 days old and three weeks later were killed and the nematodes removed for examination.

The chickens in Group I had an average of 5.0 worms, those in Group II had 2.3, while the birds in Group III had an average of 5.6 worms. The worms in Group I averaged 16.9 mm in length, those in Group II averaged 19.1 mm, and those in Group III averaged 15.2 mm. The most and shortest worms were in Group III, while the fewest and longest were in Group II (Table 5).

The chickens in Group I made the best gains in weight, with those in Group III making the poorest; all three groups were below normal (Fig. 5). This experiment was carried on in hot weather, which is probably the reason for the lighter weights of all three groups of chickens. It did not seem to affect the number or length of the worms, however.

In Group I the heaviest bird had no worms, but a bird weighing six grams less had more than the average number of worms; the lightest bird had the same number as the second heaviest. The most worms occurred in a bird slightly under average weight. In Group II the heaviest infection was in the lightest bird, and the heaviest bird had no worms. In Group III the heaviest bird had no worms, while the lightest had six times the average number. The heaviest infection was in a bird about 10 percent below average weight.

Table 5. Comparison of chicken weights and worm lengths in Groups I, II and III, Experiment 5.

Group I. Meat scraps and milk					Group II. Meat scraps					Group III. Soybean oil meal				
Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms		Chick number	Chicken's weight in grams		Worms	
	Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)		Initial	Final	Number	Average length (mm)
2244	97	512	0	0.0	2200	96	522	3	17.1	2206	96	360	42	13.9
2212	94	544	0	0.0	2211	94	530	0	0.0	2229	95	524	0	0.0
2195	90	468	4	20.3	2210	90	548	0	0.0	2232	90	386	2	15.5
2234	90	586	0	0.0	2235	90	422	0	0.0	2242	90	410	11	17.6
2198	88	466	4	12.9	2233	88	468	0	0.0	2243	88	430	0	0.0
2194	86	430	4	16.7	2191	87	400	0	0.0	2249	87	448	1	16.0
2203	86	580	8	17.4	2207	86	450	3	10.6	2213	86	500	0	0.0
2227	86	568	3	12.2	2223	86	460	0	0.0	2219	85	544	0	0.0
2216	82	518	2	13.8	2250	84	390	0	0.0	2222	82	380	0	0.0
2192	81	420	(35)	(0-16.9)	2230	82	412	1	10.8	2239	81	424	6	16.6
2197	80	420	0	0.0	2201	80	426	0	0.0	2202	80	340	0	0.0
2209	80	412	0	0.0	2218	80	490	0	0.0	2225	80	512	2	19.0
2228	80	398	0	0.0	2231	80	352	26	19.9	2247	80	320	0	0.0
2214	78	444	2	13.6						2246	78	468	0	0.0
2205	76	534	0	0.0	2238	76	500	1	17.5	2248	78	428	7	2.9
2193	76	428	0	0.0	2224	75	466	4	25.6	2240	75	370	0	0.0
2215	74	490	25	17.5						2237	72	520	0	0.0
2220	70	426	(35)	(0-16.9)	2221	68	462	0	0.0	2208	71	360	0	0.0
2245	65	336	8	19.5	2236	66	470	1	12.2	2241	65	228	36	15.7
Average	82.1	472.6	5	16.9	Average	82.0	457.0	2.3	19.1	Average	82.1	418.5	5.6	15.2

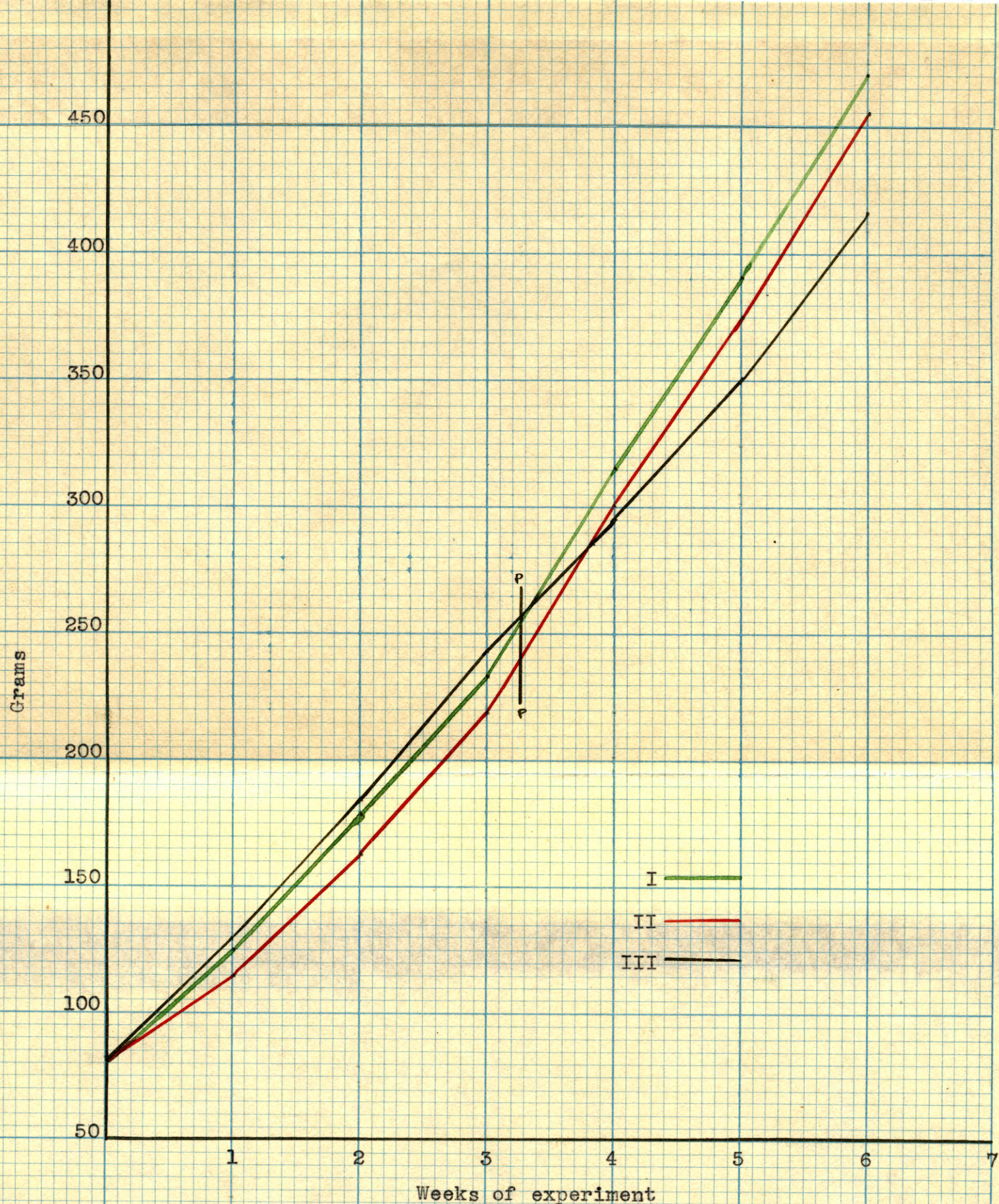

Fig. 5. Average weights of chickens in Groups I, II and III, Experiment 5. Chicks 15 days old at start of experiment. P indicates age at which the chickens were parasitized.

The data in this test indicated that soybean oil meal was not quite as effective as meat scraps and milk as a supplement, and that neither was as effective as meat scraps alone in maintaining resistance of the chickens to growth of the worms.

Combined Data of Experiments

In the five experiments there was a total of 96 chickens in Group I, and 104 each in Groups II and III. Those in Group I (meat and milk supplement) had an average of 5.8 worms, those in Group II (meat supplement) had 7.0, and those in Group III (soybean supplement) had an average of 5.0 (Table 6). The worms in Group I averaged 20.5 mm in length; those in Group II, 20.6 mm; and those in Group III averaged 19.7 mm, a maximum difference of only 0.9 mm. The variability of lengths of worms in various chickens was considerable, so that in counsel with a competent statistician, an examination of data made it obvious that the small differences between the average lengths of the worms in Groups I, II, and III were within the range of experimental error.

The combined data indicate that soybean oil meal was at least as effective as meat scraps and as meat scraps and milk in developing resistance of the chickens to the growth of the worms.

Table 6. Summary of worm numbers and lengths.

Experiment	Group I		Group II		Group III	
	Number per chicken	Length per chicken (mm)	Number per chicken	Length per chicken (mm)	Number per chicken	Length per chicken (mm)
1	14.2	23.2	14.2	23.5	10.1	22.1
2	4.0	20.5	6.5	18.5	4.2	20.5
3	3.2	21.5	3.0	18.2	2.1	19.7
4	2.4	20.5	4.5	23.9	3.4	21.1
5	5.0	16.9	2.3	19.1	5.6	15.2
Average	5.8	20.5	7.0	20.6	5.0	19.7

DISCUSSION

Care was taken at the beginning of each experiment to match the chicks of each group so that those under comparison would be of as nearly the same weight as possible. Reference was frequently made to the normal weights for single comb White Leghorn chickens, as determined by Card and Kirkpatrick (1918). While the weights of the experimental chickens approximated the normal ones for the first few weeks, they began to drop below the normal weights after about the fifth week. This might have been due to the effects of the parasitism, or perhaps to crowding, since the chickens were raised in batteries, in close confinement.

The chickens in Group III (soybean) were slightly the heaviest, those in Group II (meat scraps), in four of the five experiments, averaged lightest; while the birds in Group I (meat scraps and milk) averaged second in weight. The lighter weight of Group II may have been due to the poorer food value of meat scraps, since Van Landingham, Clark, and Schneider (1942) found

that chickens under 18 weeks of age were able to utilize only 41.9 percent of the protein in meat scraps as compared with 58 percent in casein and 76 percent of the protein in soybean oil meal.

Weight actually seemed to have little if any effect on the degree of parasitism; the lightest bird often had no worms at all, but occasionally had more than average and twice had the most worms. The heaviest bird also was often free from worms; it sometimes had an average number, and occasionally had more or fewer than average; it never had the heaviest infection. The heaviest infection ranged from the lightest bird to those weighing slightly above average. The number of worms seemed to have little if any effect on their length; that is, it did not follow that if a chicken had many worms, those worms were shorter or longer than those in a chicken with few worms.

The results as summarized in Table 6 indicate that soybean oil meal as a supplement produced chickens that tended to be slightly more resistant to the growth of the worms than did the other supplements. As the growth of the chickens on the soybean supplement was equal, if not superior, to that of chickens on the other supplements, it would appear that larger numbers of experimental chickens and worms might show a constant superiority of soybean oil meal supplement in producing resistance in the chickens to the nematode. Ackert, Edgar, and Frick (1939) showed that chickens two months of age produce a copius supply of mucin from the duodenal goblet cells, and that such mucin contains an inhibitory factor against the growth of the worms.

Ackert, Whitlock, and Freeman (1940) demonstrated that the nematodes, A. galli, feed on the intestinal contents of the host. The slightly shorter average of worms in Group III (soybean) would seem to indicate that the high percentage (76) of protein utilization of the soybean oil meal enabled the chickens to deposit in the goblet cell mucin a somewhat more potent inhibitory growth substance than did the meat and milk supplements. Further experiments on more chickens and with more worms might afford sufficient data to show constant differences in the degree of fowl resistance to the worms.

SUMMARY

1. Five experiments were conducted on a total of 304 White Leghorn chickens to ascertain if soybean oil meal could be substituted for meat or milk supplements in fowl rations without lowering the resistance of the birds to the growth of the nematode Ascaridia galli.

2. A basal cereal ration containing adequate vitamins and minerals was supplemented with approximately 20 percent of meat scraps and powdered skim milk for Group I; a similar amount of meat scraps for Group II; and approximately 20 percent of soybean oil meal for Group III.

3. After being on the experimental rations for about four weeks, each chicken was fed approximately 100 infective eggs of the nematode A. galli. Three weeks later the chickens were killed and the nematodes measured.

4. The criterion for judging the resistance was the lengths of the worms removed from each group of chickens at autopsy.

5. The measurements of the nematodes showed an average worm length of 20.5 mm for Group I, 20.6 mm for Group II, and 19.7 mm for Group III, only slight differences which were not significant.

6. The chickens having the meat scraps and powdered milk supplement had an average of 5.8 worms; those with the meat scraps supplement had 7.0; and those with the soybean oil meal supplement had an average of 5.0 worms.

7. The chickens on the ration supplemented with soybean oil meal (Group III) made slightly the best average growth, while those with the meat scraps supplement (Group II) made slightly the poorest average gains in weight.

8. The results of the experiments indicate that soybean oil meal used as a 20 percent supplement to an otherwise adequate ration is as effective as a meat scraps or meat scraps and powdered skim milk supplement in developing resistance of chickens to the growth of the nematode Ascaridia galli.

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