Proven Enzyme Solution to Maximize Feed Efficiency in Poultry Production

Will Lin, Ph.D.

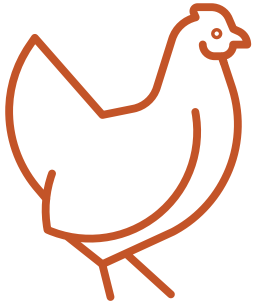
Research & Technical Director,
Alltech China

Alltech®

IN 2050

THE WORLD'S **POPULATION** WILL REQUIRE

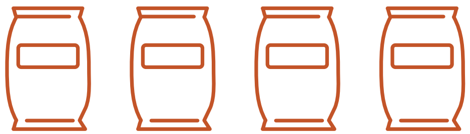
What if all of this were made of broiler chickens?



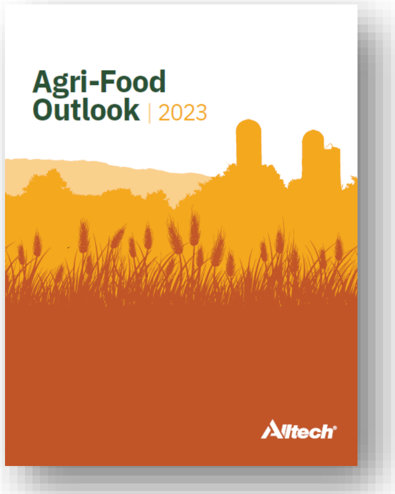
The amount of broiler chickens required to produce 500M tons of meat would require **an additional**

1,000

million metric ton of chicken feed.



2X TODAY



Global feed production

1,271.7

million metric ton

Alltech Agri-Food Outlook 2023

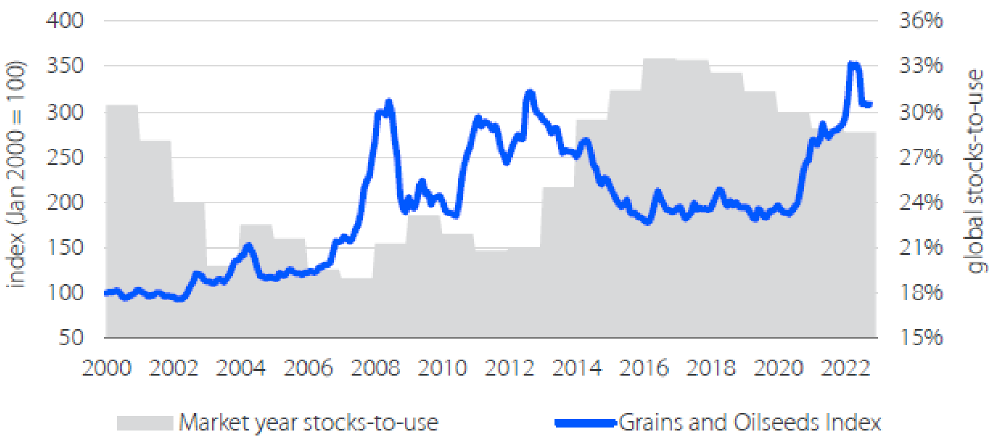
Feed costs represent the biggest input for producers, often accounting for **UP TO 70% OF PRODUCTION COSTS.**

Alltech®

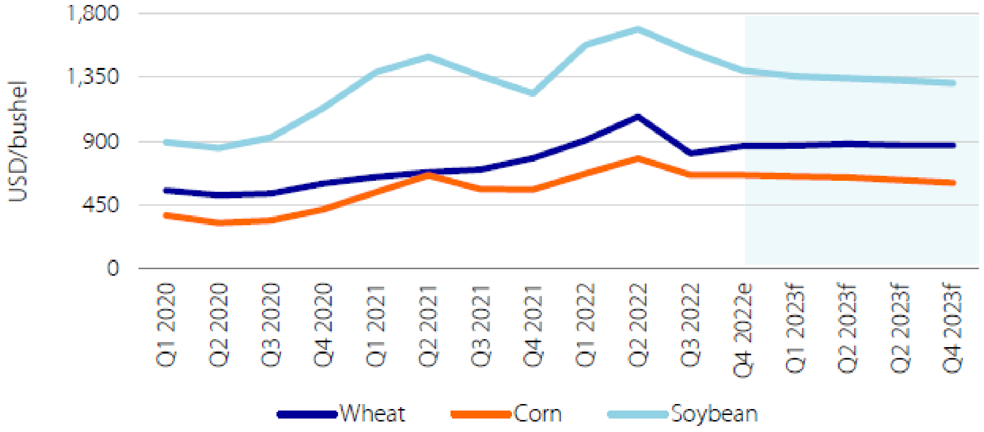
Global prices

According to Rabobank's Animal Protein Outlook 2023 report, feed price relief will be limited in 2023, challenging producer margins.

Demand for corn, soybeans and wheat is outpacing global supply.



Agri commodity prices and Rabobank forecasts

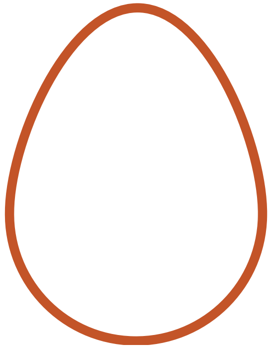


Tight global agri-commodity inventories, along with geopolitical changes (Ukraine war) and ongoing La Nina conditions, mean feed commodity prices can change rapidly.

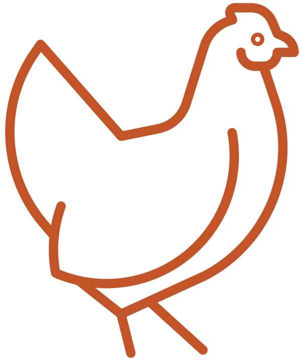
Rabobank Global Poultry Quarterly 2023

For every $10 change in the price of SBM per ton:

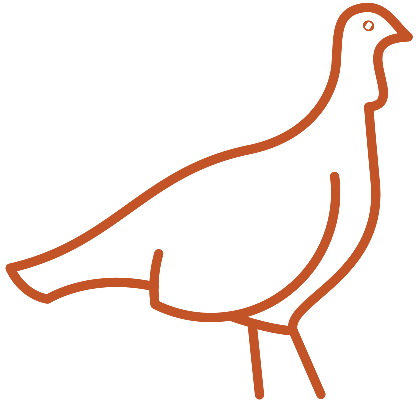
The cost of poultry production increases by



$0.44 cents per dozen of eggs.



$0.24 cents per pound liveweight in broilers.



$0.32 cents per pound liveweight in turkeys.

A hidden problem

Around 25% of the available nutrients in animal feedstuff are undigestible, leading to nutrient and caloric waste.

Utilizing an innovative mindset

TO GET MORE OUT OF LESS

- For the industry itself, an innovative mindset and willingness to adopt new technologies.
- These innovative solutions allow for **extracting more nutritional value from our existing feed resources** along with the inclusion of food and feed by-products that are fed to animals.

with feed enzymes

Alltech®

Enzymes used in poultry diets

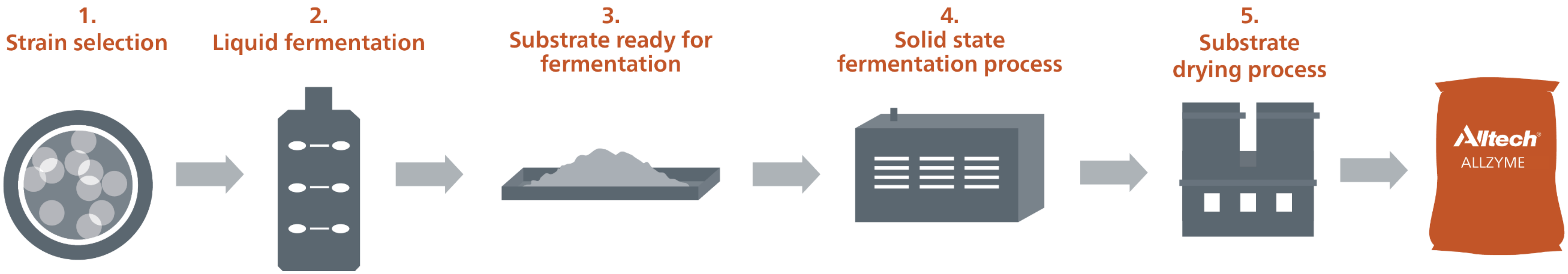
ENZYMES	SUBSTRATES	INGREDIENTS
Phytase	Phytate	Plant-based ingredients
Xylanase	Arabinoxylans (NSP)	Wheat, rye
β-glucanase	β-glucans (NSP)	Barley, oats
Pectinase	Pectins (NSP)	Lupins & vegetable meals
α-galactosidases	Oligo-saccharides	Vegetable meals
β-mannanase	Mannans	Vegetable meals
Protease	Protein	Corn, vegetable meals
Amylase	Starch	Corn, rice, wheat, sorghum

Alltech®

Multiple substrates require multiple enzymes.

A Unique SSF Technology

How does it work?



The result is ALLZYME®

8 Ph.D.s on the technology

ENZYME MANAGEMENT

43 years of **innovation**

1980
First to develop an enzyme cocktail

1986
First to develop feather-digesting enzymes (**ALLZYME® FD**)

1994
First specific enzyme for soybean meal and vegetable proteins
ALLZYME® VEGPRO

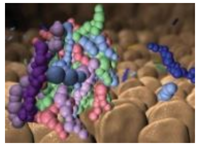
2000
First opening of a solid-state fermentation production facility (in Serdan, Mexico) to produce non-GMO feed enzyme complex

2003
First multi-enzymatic complex containing fiber, complex carbohydrates and phytate-digesting enzymes
ALLZYME® SSF

2010
Continuous research at our bioscience centers and our pilot plant studying solid-state fermentation technology

1980 | 1984 | 1986 | 1990 | 1994 | 1995 | 2000 | 2003 | 2006 | 2010 | 2015

1981
First to offer liquid feed enzymes



1992
First to develop the ultimate protein with enzymes, and first to develop *in-feed* enzyme assay procedures

1995
First to develop an enzyme for ruminants (**FIBROZYME®**), and first to develop a non-GMO phytase

2002
First to develop an enzyme for ruminants (**AMAIZE®**) to improve starch digestion

2006
First Asia-Pacific Alltech bioscience center opens in Thailand, aimed at finding appropriate solid state fermentation complexes for common Asian raw materials

2012
First to offer *in vitro* screening (**True Check™**)

2015
Eight Ph.D.'s completed in solid state fermentation technology

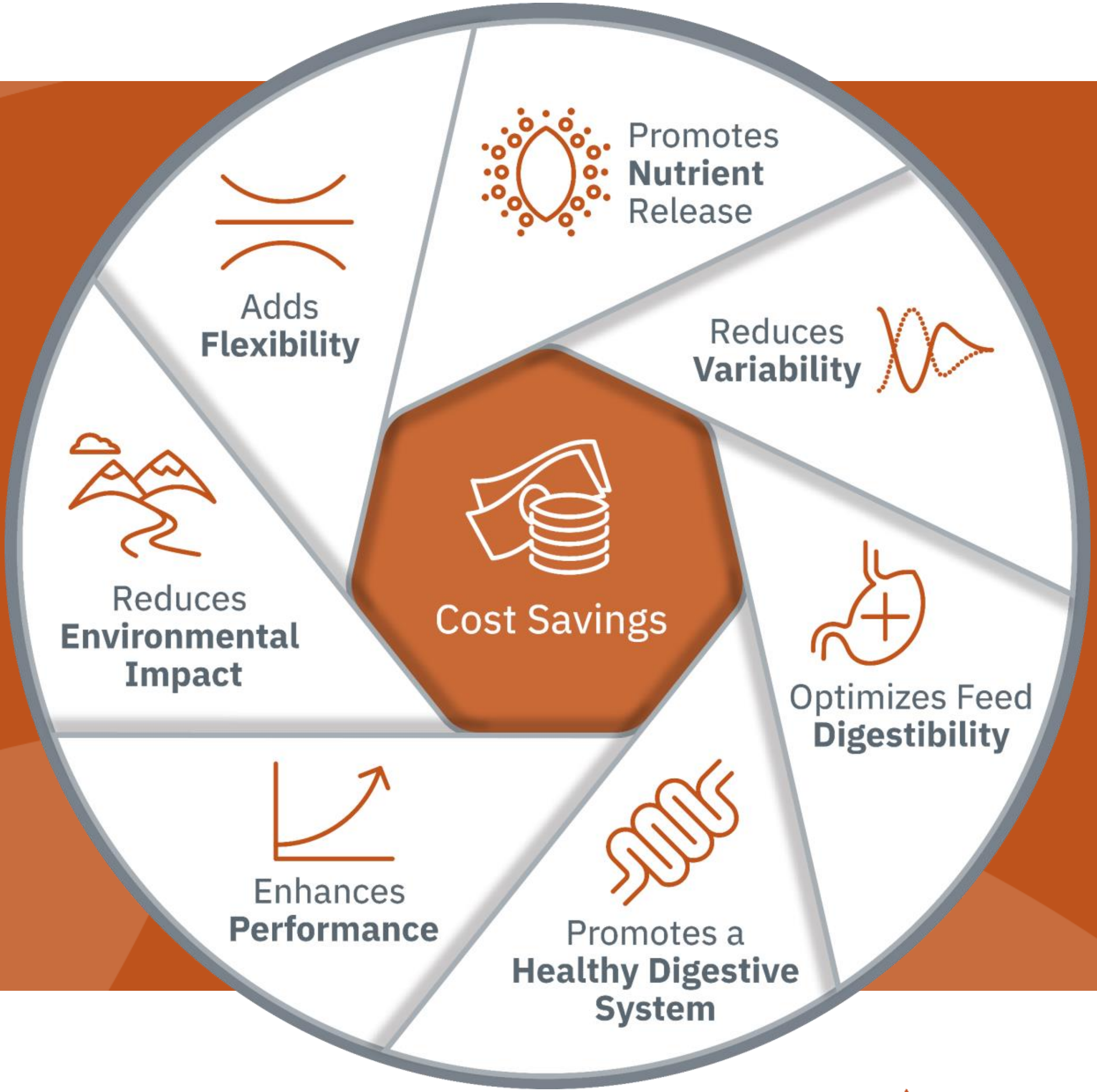
2019
The Alltech Enzyme Management platform was established, focusing on a new generation of enzymes.

2021
Introducing
NEW ENZYME INNOVATIONS

2023
New enzyme trials underway

Alltech®

BENEFITS
of a unique feed enzyme technology



Portfolio of products

	ALLZYME SPECTRUM®	ALLZYME® SSF	ALLZYME® VEGPRO
Ca/P	++++	+++	-
Protein	+	+	+++
Energy	++++	+++	++
	The newest Allzyme generation	Allzyme multi-enzyme complex	Higher **protein digestibility**

Backed by science

Meta-Analysis of Pig Trials Comparing Diets With or Without Allzyme® SSF

Danny M. Hooge, PhD
Hooge Consulting Service, Inc.
8775 Cedar Pass Road
Eagle Mountain, Utah 84005-3186
danhooge@fiber.net

An enzyme complex manufactured by solid-substrate fermentation, rather than conventional liquid fermentation (Hoskins, 2009), and containing phytase, starch, and non-starch polysaccharide enzymes is commercially available for use in pig feeds (Allzyme® SSF, Alltech, Inc., Nicholasville, KY). This enzyme product is derived from a naturally selected (non-genetically modified) strain of *Aspergillus niger* that produces phytase, xylanase, protease, cellulase, β-glucanase, amylase (Wu et al., 2003), pentosanase, and pectinase (Sundu et al., 2004). This is a natural complex or system of enzymes of fungal origin.

When the enzyme complex product is included in pig feeds at a level of 0.02% (200 g/tonne), it is estimated to release 50 kcal metabolizable energy/kg, 0.1% calcium, and 0.1% available phosphorus, as well as 0.015% lysine, 0.009% methionine, 0.004% cystine, 0.004% threonine, and 0.004% tryptophan. The efficacy of this enzyme product for reducing phosphorus excretion and for increasing ileal digestibilities of phosphorus, calcium, crude protein, and energy have been demonstrated (Park et al., 2003; Wu et al., 2003).

This article provides a statistical meta-analysis of 18 feeding trials with pigs in which effects of negative control (nCON) and enzyme supplemented (+SSF) diets were compared (29 pairs of data per parameter) for average daily gain and feed/gain. The feeding trials were conducted in several countries including Belgium, Brazil, China, Mexico, Philippines, and the U.S. Using the overall average responses, pig producers can easily calculate the benefit:cost ratios by production parameter for the enzyme supplement.

Meta-Analysis Results. Some of the basal diets used in the trials were adequate in calcium and phosphorus whereas other basal diets had reduced levels of these minerals (reformulation). As shown in Table 1, the enzyme product (+SSF) was added at 0.02% (200 g/tonne) in most of the trials. In the first 2 trials, 2 or 3 levels of product added per ton were tested, and these were reported by phytase units rather than g/tonne. Average daily gain ranged from 0.323 to 1.120 kg per pig and had an overall mean of 0.681 kg for nCON and 0.726 kg for +SSF treatment groups (P = 0.001 by paired t-test). The difference due to supplementation of the enzyme product was +0.045 kg (45 g) amounting to +6.61% improvement relative to nCON results. Feed/gain ratio ranged from 1.57 to 4.33 and had an overall mean of 2.573 for nCON and 2.342 for +SSF treatment (P = 0.003 by paired t-test). The change due to inclusion of the enzyme product was -0.231 or -8.98% relative improvement.

Meta-Analysis of Laying Hen Trials Using Diets With or Without Allzyme® SSF

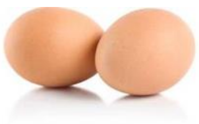
Danny M. Hooge, PhD, PAS
Hooge Consulting Service, Inc.
8775 Cedar Pass Rd
Eagle Mountain, UT 84005-3186
danhooge@fiber.net

An enzyme complex manufactured by solid-substrate fermentation, rather than conventional liquid fermentation, and containing phytase, starch, and non-starch polysaccharide enzymes is commercially available for use in laying hen diets (Allzyme® SSF, Alltech, Inc., Nicholasville, KY). This enzyme product is derived from a naturally selected (non-genetically modified) strain of *Aspergillus niger* produces phytase, xylanase, protease, cellulase, β-glucanase, amylase (Wu et al., 2003), pentosanase, and pectinase (Sundu et al., 2004). This is a natural complex or system of enzymes of fungal origin.

When the enzyme complex product is included in laying hen feeds at a level of 0.015% (150 g/tonne), it is estimated to release 75 kcal ME/kg (34 kcal ME/lb), 0.1% calcium, and 0.1% available phosphorus, as well as 0.2% crude protein, 0.029% lysine, 0.0.11% methionine, 0.009% cysteine, 0.004% tryptophane, 0.014% threonine, 0.024% isoleucine, and 0.022% arginine.

This article provides a statistical meta-analysis of 16 feeding trials with laying hens in which effects of negative control and enzyme supplemented diets on productive performance were compared. Using the overall average responses, egg producers can easily calculate the benefit:cost ratios by production parameter for the enzyme supplement.

Meta-Analysis Results. A total of 16 reports collected worldwide and containing 26 comparisons of negative control (nCON) versus enzyme supplemented (+SSF) laying hen diets were evaluated statistically by paired t-test in this meta-analysis (Tables 1 and 2). Hen-day egg production was numerically (P = 0.136) improved by 1.09% actual (+1.29% relative) for +SSF compared to nCON diets. Egg weight was significantly (P = 0.006) greater from hens fed +SSF rather than nCON diets (+0.89 g or +1.49%). Daily egg mass produced was significantly greater (P = 0.014) for +SSF than for nCON fed hens (+1.74 g/hen/day or +3.47%). Feed intake was numerically lowered by 0.50 g/hen daily (-0.44%) by using +SSF diets compared to nCON diets. Feed/dozen eggs was significantly (P = 0.028) reduced by 0.027 kg/dozen (1.65%) for +SSF diets compared to nCON diets. Similarly, kg feed/kg eggs was significantly (P = 0.004) reduced by 0.069 (3.04%) for +SSF diets compared to nCON diets. Therefore, enzyme supplementation numerically improved 2 production parameters (hen-day egg production and feed intake) and significantly improved 4 other production parameters (egg weight, daily egg mass, feed/dozen eggs, and kg feed/kg eggs).



International Journal of Poultry Science 9 (9): 819-823, 2010
ISSN 1682-8356

Meta-analysis of Broiler Chicken Trials Using Diets With or Without Allzyme® SSF Enzyme Complex

D.M. Hooge[1], J.L. Pierce[2], K.W. McBride[2] and P.J. Rigolin[2]
[1]Hooge Consulting Service, Inc., Eagle Mountain, Utah, USA
[2]Alltech, Inc., Nicholasville, Kentucky, USA

Abstract: A meta-analysis of body weight and feed conversion ratio results from broiler chicken pen trials plus a few commercial trials (2001-2009) from several countries was conducted to demonstrate effects of a dietary enzyme complex (Allzyme® SSF, Alltech, Inc., Nicholasville, Kentucky USA) versus no supplement (negative control) on live performance. In the statistical meta-analysis, 28 references provided results for 51 comparisons (paired t-test) from which overall averages for body weight and feed conversion ratio were calculated. The final age (days) in each trial or in the experimental feeding period was noted and an estimate of final age was calculated using the ending age in each trial. Broiler chicken final body weight with the dietary enzyme complex product was found to be 0.057 kg or 3.73% greater than unsupplemented chicken body weight whereas feed conversion ratio was lowered by 0.043 or 2.64% with the enzyme product. These changes in live performance exceed those of Fisher and Wilson (1974) and those predicted by linear regression analysis using data from Jackson *et al.* (1982) and Waldroup (1996) for 75 extra kcal ME/kg of diet. Therefore, the 75 kcal ME/kg uplift used in the manufacturer's ingredient matrix appears to be conservative for the enzyme complex product based on results in the cited publications. Base on results presented herein, this enzyme complex product is recommended for use in broiler chicken feeds either by addition on top to take advantage of expected benefits or by reformulating the diets with 75 kcal less ME/kg (along with -0.1% calcium, -0.1% available phosphorus and -1% essential amino acids used in formulation). The usual rate of inclusion is 0.02% or 200 g/tonne.

Key words: Allzyme SSF, broiler, enzymes, meta-analysis, metabolizable energy

INTRODUCTION

An enzyme complex manufactured by solid-substrate fermentation, rather than conventional liquid fermentation, and containing phytase, starch and non-starch polysaccharide enzymes is commercially available (Allzyme® SSF, Alltech, Inc., Nicholasville, KY) for use in broiler chicken feeds. By this method, a naturally selected (non-genetically modified) strain of *Aspergillus niger* produces phytase, xylanase, protease, cellulase, beta-glucanase, amylase (Wu *et al.*, 2003), pentosanase and pectinase (Sundu *et al.*, 2004). This is not a blend or cocktail of enzymes but a natural complex or system of enzymes of fungal origin. According to the manufacturer, the enzyme complex product included in feed at the recommended dose (200 g/tonne or 0.02%) releases 75 kcal ME/kg (34 kcal ME/lb), 0.1% calcium and 0.1% available phosphorus, as well as 1% of the amino acids.

This article presents a meta-analysis of results of broiler chicken pen trials plus a few commercial trials (2001-2009) from several countries to demonstrate effects of the dietary enzyme complex vs. no supplement (negative control) on live performance.

MATERIALS AND METHODS

Research reports, articles and slide presentations (28 references) relating to pen trials and a few commercial field trials (2001-2009; one undated during this time period) were collected from 15 countries including Argentina, Australia, Brazil, Canada, China, Honduras, India, Ireland, Latvia, Maylaysia, Mexico, New Zealand, Switzerland, Taiwan and USA. In order to be included in the statistical meta-analysis, each trial must have reported age, inclusion rate of the enzyme product in the diets, body weight or gain and feed conversion or feed/gain ratio for the 2 treatments (negative control or negative control + Allzyme® SSF). Statistical analysis was performed using 51 pairs of data for each of the parameters and conducting paired t-tests with Statistix 8 (Analytical Software, Tallahassee, Florida; www.statistix.com). The level of probability for statistical significance was $p \leq 0.05$.

RESULTS AND DISCUSSION

In Table 1, data from 28 references (2001-2009) are presented showing broiler chicken body weight and feed conversion ratio values from trials comparing treatment

Corresponding Author: D.M. Hooge, Alltech, Inc., Nicholasville, Kentucky, USA

Allzyme published meta-analysis

Reformulating diets to become more efficient

ALLZYME® SSF
Nutritional Matrix - Layers

		Layers
Use Rates		
kgs/MT (1000)		0.15
lbs/ton (2000)		0.3
	Uplift (%)	**Matrix value**
Avail. P, %	0.1001	667
Calcium, %	0.1001	667
Crude protein, %	0.2001	1334
Lysine, %	0.0290	193
Methionine, %	0.0110	73
Cysteine, %	0.0090	60
Methionine & Cysteine, %	0.0200	133
Tryptophan, %	0.0041	27
Threonine, %	0.0140	93
Isoleucine, %	0.0240	160
Arginine, %	0.0221	147
	Uplift	**Matrix value**
ME (corn-based)		
kcal/kg	75.16	501,037
kcal/lb	34.09	227,267
ME (wheat-based)		
kcal/kg	110.23	734,874
kcal/lb	50.00	333,333

Matrix value (metric) = (uplift/use rate) x 1000
Matrix value (US units) = (uplift/use rate) x 2000

If diets contain 5% meat and bone meal (M/B) then multiply Matrix value (0%) by 0.95.
If diets contain 7.5% M/B then multiply Matrix value (0%) by 0.925.

Alltech

ALLZYME® SSF
Nutritional Matrix - Broilers

		Broilers
Use Rates		
kgs/MT (1000)		0.2
lbs/ton (2000)		0.4
	Uplift (%)	**Matrix value**
Avail. P, %	0.1000	500
Calcium, %	0.1000	500
Crude protein, %	0.2000	1000
Lysine, %	0.0290	145
Methionine, %	0.0110	55
Cysteine, %	0.0090	45
Methionine & Cysteine, %	0.0200	100
Tryptophan, %	0.0040	20
Threonine, %	0.0140	70
Isoleucine, %	0.0240	120
Arginine, %	0.0220	110
	Uplift	**Matrix value**
ME (corn-based)		
kcal/kg	75.16	375,778
kcal/lb	34.09	170,450
ME (wheat-based)		
kcal/kg	110.23	551,156
kcal/lb	50.00	250,000

Matrix value (metric) = (uplift/use rate) x 1000
Matrix value (US units) = (uplift/use rate) x 2000

Alltech

ALLZYME® VEGPRO
Nutritional Matrix - Broilers and Layers

		Broilers and Layers
Use Rates		
kgs/MT (1000)		0.5
lbs/ton (2000)		1
	Uplift (%)	**Matrix value**
Avail. P, %	0.00025	0.5
Calcium, %	0.00025	0.5
Crude protein, %	0.8400	1680
Lysine, %	0.0564	112.7
Methionine, %	0.0126	25.2
Cysteine, %	0.0139	27.7
Methionine & Cysteine, %	0.0265	52.9
Tryptophan, %	0.0124	24.8
Threonine, %	0.0343	68.6
Isoleucine, %	0.0455	91
Arginine, %	0.0630	126
Valine, %	0.04375	87.5
	Uplift	**Matrix value**
Metabolizable energy		
kcal/kg	44.67	89,331
kcal/lb	20.26	40,520

Same values for young and adult birds on Allzyme Vegpro and same ME for corn and wheat diets.

Matrix value (metric) = (uplift/use rate) x 1000
Matrix value (US units) = (uplift/use rate) x 2000

Alltech

Alltech®

Allzyme SSF

META-ANALYSIS

BROILERS:

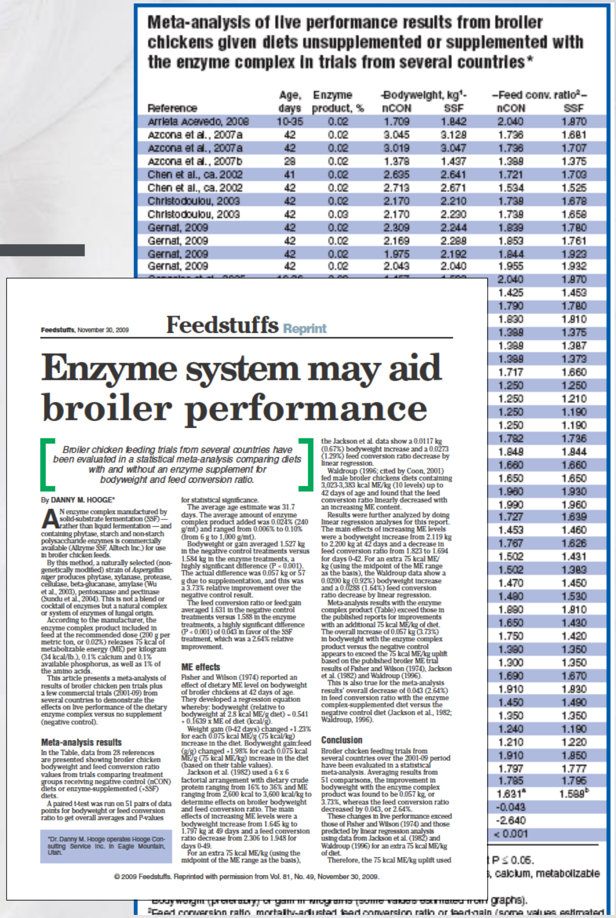
3.73% more live weight

2.64% better feed conversion

LAYERS:

3.47% more egg mass

3.09% less feed intake



117 trials in poultry, including **68** broiler, **42** layer

Alltech®

Supporting our commitment to sustainability

Feed enzymes: Sustainability impact	SDGs	KPI
Reduces greenhouse gas emissions (CO_2, CH_4, N_2O)	13 CLIMATE ACTION	GHG emissions in metric tons of CO_2 equivalent
Reduces nutrient emissions (PO_4, NO_3)	14 LIFE BELOW WATER; 15 LIFE ON LAND; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Digestibility rate; phosphorus and nitrogen reduction in manure
Minimizes use of land, water and energy	15 LIFE ON LAND; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Use of soybean meal and oil
Improves animal health and welfare	15 LIFE ON LAND; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Digestive system integrity and animal performance improvement

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

6 CLEAN WATER AND SANITATION

17 PARTNERSHIPS FOR THE GOALS

SUSTAINABLE DEVELOPMENT GOALS

Alltech®

Enzymes **reduce** the carbon footprint

Overall emissions improvements amongst different enzyme technologies

What does this mean for a one million bird production system?

Emissions reduction	Phytase only	Allzyme Vegpro	Allzyme SSF	Allzyme Spectrum
Tons CO_2e saved from baseline	25.9	447.9	515.8	660.3
Trans Atlantic flights (LHR - JFK)	-30	-521	-600	-767
Cars off road (UK)	-17	-293	-337	-431

IMPROVED EFFICIENCY.

GREATER SAVINGS.

Alltech®

FUTURE-
FOCUSED

Alltech's feed enzymes are instrumental in helping producers meet the global demand for protein. Together, we can optimize animal health and performance, farm profitability and environmental sustainability.

Alltech®


Working
Together
for a
Planet
of Plenty™
Alltech®