

Food Additives: Regulations and Repercussions

Mariah Hensley

Faculty Sponsor: Dr. Ray Block, Jr., Department of Political Science/Public Administration

ABSTRACT

Health care costs persist, and U.S. citizens struggle daily with food intake. The U.S. relies on packaged and processed food for consumers that is full of food additives, which can have harmful effects on human health. The purpose of my research is to see if a correlation exists between a country's food additive regulations and its health care costs. To see if such a correlation exists, multiple countries from around the world are examined. A country's total health expenditure, as a percentage of GDP, is used as the dependent variable and was obtained from the World Bank. To measure the "strictness" of food additive regulation in a country, 12 additives deemed to be "The Banned Bad Boys" in *Rich Food, Poor Food* by Jayson Calton, PhD, and Mira Calton, CN, are used as a base for measuring the independent variable. Data for each country regarding which additives are permitted was gathered from the United States Department of Agriculture FAIRS (Food and Agricultural Import Regulations and Standards – Narrative) Report. Using correlation analysis in Stata, it was discovered that a positive relationship exists between how "permissive" a country is with respect to its food additive policies and how much a country spends when it comes to health care. This suggests that food additive policies may be contributing to adverse health outcomes, meaning that countries that are more lenient in their food additive regulations, such as the U.S., are providing channels for the harmful effects of food additives to reach consumers and, ultimately, diminishing citizens' health while also enabling high health care costs.

Keywords: food additives, health care expenditure, World Bank, U.S. Department of Agriculture (USDA), Food and Agricultural Import Regulations and Standards (FAIRS) Report

INTRODUCTION

Additives directly affect everyone, since they are present in the food we consume daily. Food additives come in many forms, and while some occur naturally and can be beneficial, most are used to manipulate our taste buds or deceive our eyes. These additives find clever ways to enter into our digestive systems, and they can result in many harmful effects throughout the entire human body, including the brain. There are thousands of food additives already in existence and more to be discovered, all while regulation on their usage is lagging behind. This topic is important because we are all directly affected by the use of food additives, and the extent of their effects on human health is not known. As members of an increasingly global community, it is important that we raise awareness about what we put into our bodies, for the lack of such awareness can have dire health-related consequences. My interest in the topic of food additives, combined with my passion for global politics, inspires me to ask the following research questions:

- *Do countries vary when it comes to how strict or permissive they are regarding the types of food additives they allow?*
- *If so, does this strictness or permissiveness ultimately affect the health outcomes of the citizens in these countries—and, by extension, the country's health care expenditures?*

In this paper, I will explore the connection between a country's health-related expenditures (how much money a country devotes to health issues) and policies regarding food additives (more specifically, how strict food additive regulations are). In the second section, I review the limited and highly-specialized literature on food additive policies and health outcomes. The third section of this paper outlines my expectations regarding how this relationship works. In the fourth section, I discuss my data analyses and results. I offer some concluding remarks in

section five, and I acknowledge the limitations of my study while considering possibilities for future research on this important topic.

FOOD ADDITIVES AND HEALTH OUTCOMES: A LITERATURE REVIEW

Covered in an *ABC News* report, a story was done on spicy snacks sending kids to the emergency room, specifically focusing on Hot Cheetos (Mohney 2013). Doctors were seeing kids, along with some adults, coming into the emergency room with gastritis, an inflamed stomach lining, or other ailments arising after eating spicy snack foods. Dr. Martha Rivera, featured in the article, stated that she sees between five and six cases of children with gastritis daily; and, another physician, Dr. Robert Glatter believes that the flavoring coating the snacks is what might be causing the stomach pH to change, since “people aren’t coming in doubled over from eating too much spicy salsa” (Mohney 2013). Is it possible that flavoring in the food could be so harmful on the stomach? If so, why is it permissible? This question is what initially grasped my interest in food additives, and another story on the presence of BVO in Gatorade is what pushed that thought provoking question into fact-finding action.

The *Chicago Tribune* published an article entitled “U.S. Allows Chemicals in Food that are Illegal Elsewhere.” The article exposes an astonishing fact: Gatorade contains BVO, or brominated vegetable oil, which shares an element with some flame retardants used in furniture and plastics. It is proven to be harmful to health and is outlawed in more than 100 countries, including the European Union, India, Nepal, Canada, Brazil, and Japan. What is even more appalling is that companies such as PepsiCo, who currently manufactures Gatorade, alter the ingredients of products so that they abide by the laws of countries and can still reach those markets, yet continue to use harmful additives in the United States (Eng 2013).

Dr. Jayson Calton and nutritionist Mira Calton spent six years researching food additives, traveling to over 100 countries. Out of the 150 food additives studied, they declared 12 to be “the worst.” These 12 additives are all currently allowed in U.S. products, and the Caltons’ book *Rich Food, Poor Food: The Ultimate Grocery Purchasing System* is an informative guide on how to stay away from the harmful effects. *Rich Food, Poor Food* guides the reader through a grocery store that on average contains nearly forty thousand items (Calton and Calton 2013).

Table 1. “The Banned Bad Boys”: 12 food additives and their widely-documented health-related risks

Food Additive	Found In	Health Hazard
Blue #1 (Brilliant Blue FCF) & Blue #2 (Indigotine, Indigo Carmine)	Candy, cereal, soft drinks, sports drinks, and pet food	Shown to cause brain cancer and inhibit nerve-cell development
Yellow #5 (Tartrazine)	Gelatin dessert, candy, pet food, and baked goods	Studies show it can cause genotoxicity, a deterioration of the cell’s genetic material with potential to mutate healthy DNA
Yellow #6 (Sunset Yellow FCF)	American cheese, macaroni and cheese, candy, and carbonated beverages	Causes tumors in the kidneys and adrenal glands of laboratory animals
Olestra (Olean)	Reduced-fat chips	Depletion of fat-soluble vitamins and carotenoids; causes severe gastrointestinal disturbances
Brominated Vegetable Oil (BVO)	Soda and sports drinks	Competes with iodine for receptor sites in the body, causing brominated thyroid. Elevated bromide levels have been implicated in every thyroid disease (ex: hypothyroidism, autoimmune diseases, thyroid cancer), and it is linked to major organ system damage, birth defects, growth problems, schizophrenia, and hearing loss
Potassium Bromate (Bromated Flour)	Bread crumbs, wraps, rolls, and bagel chips	See bromine above. May cause kidney or nervous system disorders, gastrointestinal discomfort, and

		it is believed to be carcinogenic
Azodicarbonamide	Breads, frozen dinners, and baked goods	Asthma-causing allergen
Butylated Hydroxyanisole (BHA) & Butylated Hydroxytoluene (BHT)	Gum, nuts, breakfast cereals, and meats	Linked to carcinogenicity in rats, BHA may be a human carcinogen. BHT can cause organ system toxicity
Synthetic hormones (rBGH/rBST)	Milk, cream, and cheese	Linked to breast, colon, and prostate cancers
Arsenic	Poultry	Human carcinogen

* *Source:* Adapted from information based on information presented in *Rich Food, Poor Food* (Calton & Calton 2013).

It is important to be aware of what we are consuming, as it ultimately impacts our health. MSG, or mono sodium glutamate, which is not even included on the Caltons' list, is a flavor enhancer found in almost all processed and packaged foods. Its common side effects are changes in blood pressure, joint pain, diarrhea, blurred vision, irregular heartbeat, depression, an inability to talk, anxiety or panic attacks, migraines, and seizures (Calton and Calton 2013, 25). Since the 1950s it has been known that a single dose of MSG could destroy the neurons in the inner layer of a rat's retinas and severely damage the hypothalamus of the brain, when a study demonstrated that it can cross the blood-brain barrier and consequently overexcite the nerves, causing them to malfunction (Calton and Calton 2013, 25). What is even scarier is that studies show that humans are up to six times more sensitive to the effects of MSG than rats are (Calton and Calton 2013)! Studies on rats have also shown that MSG-induced obesity lowers sperm production and reduces sperm storage (Fernandes et al. 2012), as well as that MSG consumption alters the histology of the ovaries (Ilegbedion, Onyije, and Chibuikwe 2013).

MSG stimulates taste buds, making foods more appetizing, even those that are extremely bland or spoiled. MSG also seems to make us leptin resistant, which is the hormone that makes us feel satiated (Calton and Calton 2013). Since food tastes better and the hormone indicating a full stomach is lacking, MSG easily contributes to obesity. The prevalence of diabetes can also be attributed to MSG, which causes the pancreas to secrete insulin. When the body over-releases insulin, it can lead to Type 2 Diabetes and heart disease, as well as many other health issues (Calton and Calton 2013).

In 2010, 3.7 million people in the U.S. received hospital inpatient care for newly diagnosed cases of heart disease. The average length of stay was 4.6 days in the hospital (Centers for Disease Control and Prevention 2014). From this information arises a thought-provoking question: how much of this could have been reduced by having more strict regulations on food? For instance, how big of a role did MSG play? A study in Spain found that mice injected with MSG increased their food intake by more than 40 percent (Calton and Calton 2013). This ingredient is in almost all American processed and packaged food, and therefore the prevalence of obesity that persists could possibly be mitigated.

After having reviewed relevant literature on food additives and associated health outcomes, my suspicion that a link exists between the two seems to be plausible. The presence of food additives, such as MSG (input), can lead to poor health conditions, such as obesity (outcome). Therefore, I will now turn to specifying hypotheses regarding the relationship between these factors.

RESEARCH OBJECTIVES AND HYPOTHESES

As noted above, the objective of my research is to determine if a relationship exists between a country's health-related expenditures (how much money a country devotes to health issues) and policies regarding food additives (more specifically, how strict food additive regulations are). Based on my understanding of the literature, it is expected that the stricter a country's food regulations are, the lower its total health expenditure will be, as expressed as a percentage of the country's GDP. The opposite is also expected to hold true: the more lenient a country's food regulations are, the higher its total health expenditure will be. My hypothesis can be denoted by:

H₁: A positive relationship exists between how "permissive" a country is with respect to its food additive policies and how much a country spends when it comes to health care

H₀: There is no relationship between food-additive permissiveness and health care expenditure

DATA AND METHOD

Nutritionist Mira Calton and Dr. Jayson Calton provided a list of the 12 worst food additives out of the 150 studied. These 12 additives (Table 1) were used to measure how strict a country's food additive regulations are. The United States Department of Agriculture (USDA) FAIRS (Food and Agricultural Import Regulations and Standards – Narrative) Report provided for each country was my source for finding how many of the 12 food additives were permitted within that country. The FAIRS Reports provided reliable information that may not have otherwise been obtained due to lack of resources in some countries, and were used on the basis that if the country allows an additive to be imported, whether it is produced in that country or not, it is still allowing a channel for its citizens to be affected.

The dependent variable for testing my hypothesis was the total health expenditure, as a percentage of a country's Gross Domestic Product (GDP), the monetary value of all the finished goods and services produced within a country's borders at a given point in time. The health care expenditure data was provided by the World Bank. I used the most current information, resulting in data from 2011 as the base measurement for each country examined. I started with 234 countries from this list. I then went through the list of countries to find which ones had available FAIRS Reports, making sure they were relatively current (years 2009-2013 used). This resulted in 77 countries that were further examined. To create the independent variable for this study, each FAIRS Report was thoroughly looked over, other resources listed within the report were referred to if a permitted food additive list was not provided within the report itself, and the allowance of any of the 12 food additives was recorded for each country in an Excel Spreadsheet, sorted by country. After examining the reports, the list then again reduced significantly, resulting in 25 countries that could be used for testing my hypothesis.¹

The data was taken from the Excel Spreadsheet and imported into Stata, a statistical software program, to see if a relationship existed between the health care expenditure of a country and its allowance of additives out of the 12 examined, acting as representation of its overall food additive policy.

ANALYSIS AND RESULTS

Table 2 reports trends in food-additive permissiveness (measured here as a count of the number of the “banned bad boys” allowed) and health care expenditure rates for each country. Overall, the results in Table 2 show that countries that score high on my “permissiveness” variable tend also to score high on the “expenditure” variable. The converse is also true: less-permissive countries tend to devote a smaller percentage of their GDP on health care-related costs.

For example, the United States allows all 12 food additives and spends 17.85% of its GDP on health care, while Bahrain allows six of the 12 food additives and spends 3.8% of its GDP on health care.

Table 2. Country-level data on health care expenditure and allowance of food additives out of 12 examined

Country	Health Care Expenditure (% of GDP)	Allowance of Food Additives
Australia	9.03	6
Bahrain	3.79	6
Barbados	7.66	6
Bulgaria	7.27	6
Canada	11.18	8
Chile	7.46	7
China	5.16	7
Croatia	7.81	6
Czech Republic	7.38	6
Finland	8.85	6
Germany	11.06	6
India	3.87	6
Italy	9.50	6
Japan	9.27	7
Lithuania	6.61	6

¹ The other countries had to be thrown out due to language barriers, inconsistency, or lack of resources and/or time.

New Zealand	10.08	6
Norway	9.07	6
Panama	8.18	6
Russian Federation	6.20	8
Spain	9.44	6
Sweden	9.36	6
Thailand	4.06	7
Ukraine	7.19	6
United States	17.85	12
Vietnam	6.81	7

*Note: Health care expenditure rounded to the nearest hundredth

To look more directly at the hypothesized relationship, a Pearson’s correlation analysis was used to examine whether a statistically significant association exists between health care expenditure and the number of additives allowed out of the 12 being analyzed (for details about Pearson’s correlation analysis, see Liebetrau 1983). This correlation estimate measures relationships on a -1 to +1 scale, where -1 indicates a perfectly inverse relationship (i.e., a country’s health expenditure tend to rise as food additive policies become less permissive), estimates of +1 denote a perfectly positive relationship (i.e., health expenditures are increasing with food additive permissiveness), and correlation estimates of zero (0) signify that no relationship exists between these variables. The Pearson’s correlation estimate for this analysis was .59, which indicates that there is a strong and positive relationship. To illustrate this finding, I presented a scatterplot that visually shows that a positive relationship does exist between how “permissive” a country is with respect to its food additive policies and how much a country spends when it comes to health care (Figure 2). Each country is represented as a data point in this scatterplot (country codes are used so that readers can determine where each country fits in terms of food additive permissiveness and health care expenditures), and a regression line was added to this scatterplot to summarize this positive relationship. Based on the information in Figure 1, it is safe to reject the null hypothesis that there is no relationship between these variables.

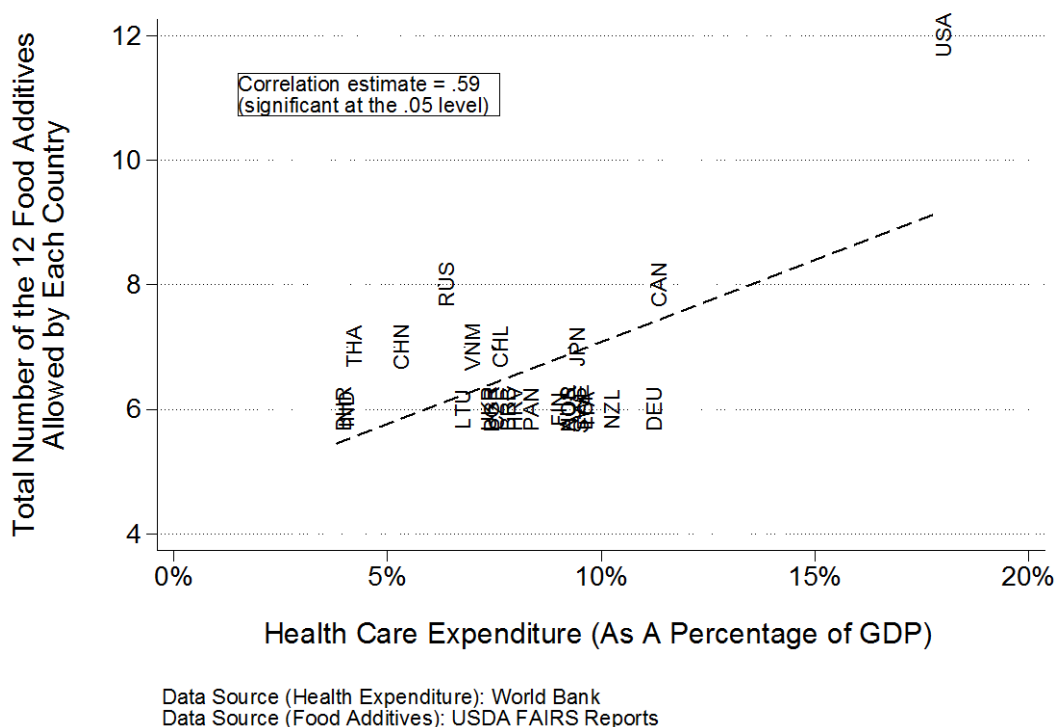


Figure 1. A scatterplot of the correlation between food additive policy and health care expenditure

DISCUSSION AND CONCLUSION

There is preliminary evidence to support my research hypothesis that a positive relationship exists between how “permissive” a country is with respect to its food additive policies and how much a country spends when it comes to health care. The results indicate that if the U.S. were to take food additives more seriously and implement stricter methods in regulating their usage, the costs associated with health care could be reduced. Therefore, this project may suggest that if more preventative measures are taken it could reduce the prescriptive/reactive measures currently needed.

LIMITATIONS

One of the more obvious limitations was data-related: My research started with 234 countries and only 25 of those countries provided me with data I was able to analyze for my results. This limited the variation of countries, since many with a low health expenditure did not have resources amply available where food additive policy could be examined. Many reports could not be used due to unreliable contacts, language barriers, or the lag time in having to purchase a copy from a particular agency. The naming of food additives provided inconsistency and could have also limited my research. For example, Blue #2 is also referred to as Indigotine or Indigo Carmine, as well as its E number 132. This could limit my findings since there is no way of knowing all name variations of a food additive when the food additive system itself is inconsistent. And, although a country allows a food additive, it may still be stricter in its regulations than another. This is because maximum levels at which an additive is allowed can differ between countries, as well as the number of products it is allowed in.

Another limitation of this study is more conceptual: there are many reasons why people get sick—and therefore require health care, which, in turn, raises the amount of money a country spends on health care. I argue that food additives play a large role in determining health outcomes, but I admit that food additives are but one of many factors that can affect the health of a country’s citizens (for example, access to clean drinking water, disease preventing medicine, etc.). That said, acknowledging the potential role of other risk factors does not minimize the importance of the current research. Rather, by exploring the impact of food additive, my work seeks to expand the conversation about health care and health-related outcomes in our global community.

PLANS FOR FUTURE RESEARCH

Future research should include the aforementioned variables of the maximum level allowed and the number of products an additive is limited to. A larger time frame should also be incorporated to allow a more in-depth analysis of food additives, providing further insight into associated effects of the current complex and inconsistent system. Researchers should more broadly assess the prevalence of food additives, perhaps through a yet to be discovered equation, since my time and accessible resources allowed for merely 12 of the thousands that exist to be examined. Future research, in expanding on my work, should take into account the percentage of government funding allocated to health care, since it could ultimately affect the percentage of health care expenditures as a percentage of GDP, thereby impacting the relationship between health care costs and food additive regulations. The topic of food additives and their resulting effects on people is one with little research and more substantial data is needed.

ACKNOWLEDGEMENTS

I would like to thank Dr. Ray Block, Jr., who inspired me to pursue my own research and became my mentor in carrying it out. Without his guidance, this project would not have been possible, and it is because of his influence my step toward change, no matter how small, has been taken. I would also like to thank the University of Wisconsin La Crosse for providing me with invaluable skills throughout my undergraduate career, as well as my friends and family whose overwhelming support is a blessing each day. Lastly, I thank Jayson and Mira Calton for their work done on food additives, which not only serves as a basis for my research, but also has put forward a movement of awareness that continues to better people’s lives.

REFERENCES/LITERATURE CITED

- Biasetti, Dana. 2013. *FAIRS Country Report – Italy*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report IT1394.
- Boshnakova, Mila. 2013. *FAIRS Country Report – Bulgaria*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report BU1364.

- Calton, Jayson, and Mira Calton. 2013. *Rich Food, Poor Food: The Ultimate Grocery Purchasing System*. Malibu, CA: Primal Blueprint Publishing.
- Crothers, Lindy. 2011. *FAIRS Country Report – Australia*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report AS1123.
- Dessureault, Darlene, Robin Gray, and Mihai Lupescu. 2012. *FAIRS Country Report – Canada*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report CA11073.
- Eng, Monica. 2013. “U.S. Allows Chemicals in Food that are Illegal Elsewhere.” *Chicago Tribune* (January). http://articles.chicagotribune.com/2013-01-21/news/ct-met-banned-food-practices-20130121_1_safety-of-food-additives-bvo-ingredient
- FAS Tokyo. 2013. *FAIRS Country Report – Japan*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report JA3046.
- FastStats: Heart Disease*. 2014. Centers for Disease Control and Prevention. Accessed: 16 March 2014. <http://www.cdc.gov/nchs/fastats/heart.htm>
- Fernandes, Glauro S. A., Arielle C. Arena, Kleber E. Campos, Gustavo T. Volpato, Janete A. Anselmo-Franci, D, bora C. Damasceno, and Wilma G. Kempinas. 2012. “Glutamate-Induced Obesity Leads to Decreased Sperm Reserves and Acceleration of Transit Time in the Epididymis of Adult Male Rats.” *Reproductive Biology & Endocrinology* 10 (1): 105 –10.
- Gonzalez, Omar. 2011. *FAIRS Country Report – Barbados*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report CB1126.
- Govindan, A. 2009. *FAIRS Country Report – India*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report IN9113.
- Guerrero, Marta. 2013. *FAIRS Country Report – Spain*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report SP1316.
- Huong, Bui Thi, and Truong Minh Dao. 2009. *FAIRS Country Report – Vietnam*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report VM9078.
- Ilegbedion, I. G., F. M. Onyije, and O. O. Chibuikwe. 2013. “Infiltration of Inflammatory Cells in the Ovary Following Oral Administration of Monosodium Glutamate.” *Bangladesh Journal of Medical Science* 12 (October): 413 –18.
- Liebetrau, Albert M. 1983. *Measures of Association*. Vol. 32 of *Series: Quantitative Applications in the Social Sciences*. Newbury Park, CA: Sage Publications.
- Meador, M., and Ma Jie. 2013. *FAIRS Country Report – China*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report 13069.
- Mikulasova, Jana. 2013. *FAIRS Country Report – Czech Republic*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report EZ1315.
- Misir, Andreja. 2013. *FAIRS Country Report – Croatia*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report HR1310.
- Mohney, Gillian. 2013. “Super Spicy Snacks Send Kids to Emergency Room.” *ABC News* (November). <http://abcnews.go.com/Health/super-spicy-snacks-send-kids-emergency-room/story?id=20899643>
- Ramirez, Nelson. 2013. *FAIRS Country Report – Chile*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report CI1324.
- Rehder, Leif Erik. 2013. *FAIRS Country Report – Germany*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report GM13005.
- Riker, Chris. 2013. *FAIRS Country Report – Russian Federation*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report RS1305.
- Sharma, Vinita. 2011. *FAIRS Country Report – New Zealand*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report NZ1118.
- Tarashevych, Alexander. 2013. *FAIRS Country Report – Ukraine*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report UP1344.
- Taha, Mohamed. 2011. *FAIRS Country Report – Bahrain*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report BAH 01-2010.
- The World Bank*. 2014. World Bank Group. Accessed: 11 March 2014. <http://www.worldbank.org>
- Tmanova, Lyubov, Brian D. Healy, Jolanta Figurska, and Piotr Rucinski. 2013. *FAIRS Country Report – Lithuania*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report LH 1303.
- Vasquez, Orestes, Sakchai Preechajarn, and Sukanya Sirikeratikul. 2012. *FAIRS Country Report – Thailand*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report TH0172.

- Villalaz, Arlene. 2010. *FAIRS Country Report – Panama*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report PN10009.
- Wideback, Asa. 2011. *FAIRS Country Report – Finland*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report FI1102.
- Wideback, Asa. 2011. *FAIRS Country Report – Norway*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report NO1002.
- Wideback, Asa. 2012. *FAIRS Country Report – Sweden*. Washington D.C.: USDA Foreign Agricultural Service. GAIN Report SW1203.