



Impact of educational level in public perception on biotechnology in Southern Cebu, Philippines

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ABSTRACT

Since the introduction of biotechnology in the Philippines, the concept and applications have not been well understood due to several barriers that limit information dissemination. The study used a semi-structured interview to assess the likelihood of educational background, which referred to the highest educational attainment, in the public's perception of biotechnology in Southern Cebu. Significant results were found among college graduates being more aware and knowledgeable in biotechnology and its uses in food production. The same group of respondents and those who reached the college level highly trusted information from scientific sources such as academe/researchers, books, seminars, and forums. Those who reached the elementary level and elementary graduates highly trusted and read information from acquaintances, religious figures, and the internet. Individuals who reached college level and college graduates also have a positive attitude and perception towards biotechnology and are willing to attend seminars and participate in policy-making. The same groups of respondents perceived no harm and are less concerned with biotechnology in food production and agricultural development. The result showed that the public perceived biotechnology as a cultural concern in Southern Cebu other than ethical/moral, religious, health, environmental and political. Based on the results, education levels influenced the public's knowledge, perception, and understanding of biotechnology and its applications in food production, public health and safety, and agricultural development. The major practical contribution of this study is that it provides empirical data on the public's attitude, knowledge, and perception of biotechnology that can be used to develop strategies for effective information dissemination.

KEYWORDS: *awareness, biotechnology, education, perception, Southern Cebu*

1 INTRODUCTION

Biotechnology has been around since ancient civilizations. As defined by Miller (2013), it uses technology to modify or upgrade the part or whole of the biological system for industrial and human welfare. Biotechnology, in general, is a series of enabling technologies, including the manipulation of living organisms at the subcellular level, to develop useful products, processes, and services (Alemu, 2020). The term biotechnology was first coined in a book published in 1919, by Karoly Erekey, a Hungarian engineer (Raju, 2016). The term can be classified into conventional and modern biotechnology. Conventional, also called traditional, biotechnology includes selective breeding of crops and animals and utilization of microorganisms for specific purposes such as making cheese, yogurt, bread, beer, and wine (Gupta *et al.*, 2016; Bhatia, 2018). On the other hand, modern biotechnology deals with the technique that uses recombinant DNA technology to modify the genetic composition of microorganisms, plants, and animals for all kinds of applications (Tramper & Zhu, 2011).

The Philippines, through the University of the Philippines, is one of the first Asian countries that engaged and established research in biotechnology and its related fields of application (Padolina, 2001). In 2017, the Philippines ranked 13th in world biotech crop commercialization, with 642,000 ha of land area planted with biotech corn (ISAAA, 2017). However, the application of biotechnology in rural areas is less known, even though it has already been used in farming and industries.

One of the main reasons for this is the difficulty in disseminating information and technology about biotechnology, especially in rural areas. From 2000-2001, the Philippine media relied on limited and sometimes inaccurate information on biotechnology, in general, which has made the delivery of uncertain and vague information on biotechnology. However, clear information started to take over during the release of

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biotech corn in 2003. In the succeeding years, science-based and credible sources became the norm. However, this depends on a specific topic of interest that resulted in controversies, such as in the case of the Bt corn and Bt eggplant (Tome *et al.*, 2017). The same scenario happened in 2015 when the Supreme Court of the Philippines issued its ruling against field testing of Bt eggplant. The decision became a focus in the local press which made experts and scientists explain their research (Ponce de Leon *et al.*, 2019).

Although biotech crops faced controversies, several reports mentioned their benefits and potential global economic and environmental impacts. Brookes & Barfoot (2009) highlighted the significant contributions of biotech crops 12 years since they were planted (1996-2007). The technology played a role in raising the global production of major crops by improving the production yield of farmers and reducing the production risks. Significant direct economic contributions of biotech crops were also observed from 1996-2009 which benefited farmers in developing countries (Brookes & Barfoot, 2011). In 2018, a report stated that GM crops resulted in \$18.95 billion in direct global farm income and a \$225 billion increase in the farm income since 1996, 23 years since they were first planted. In addition, the Philippines has an estimated more than 15% increase in the yield of GM maize during the first two years of adoption (Brookes & Barfoot, 2020). In general, scientific work is not a popular topic in the country due to lack of regular science sections, science journalists and editors, and regular scientific coverage in the Philippine media outlets (Talisayon *et al.*, 2006; Ponce de Leon *et al.*, 2019). In addition, there is a difficulty in communicating the concept of scientific doubt to the public. Instead, scientific doubt is perceived as a lack of understanding while scientists focus on the concept as part of the process and are hesitant to talk in absolute terms (Zajc & Erjavec, 2014; Hardy *et al.*, 2019; Ponce de Leon *et al.*, 2019). The lack of understanding in the concept can lead to misinterpretation of the information. A study of Turker *et al.* (2013) found a significant result among nursing students not being informed on GMO's prompted them to agree that biotechnology is risky and dangerous.

Educational background also affects the public's understanding, attitude, and perception towards biotechnology. People's perceptions of biotechnology are related to their knowledge and adequate understanding of the fundamental concepts. More informed individuals had favorable opinions about biotechnology; therefore, efforts are required to increase knowledge among college students about biotechnology and GM crops (Tagegne *et al.*, 2013). Hossain *et al.* (2003) found positive correlation between respondents' education and knowledge of science to their support in the use of biotechnology in plants. They further added that younger

and higher educational background individuals have positive perception on biotechnology's potential to improve the quality of life. Sohan *et al.* (2002) investigated the educational base as a possible factor influencing the perception towards biotechnology. They found significant differences between class levels, with seniors having a more positive attitude towards biotechnology compared to lower class levels.

Fritz *et al.* (2003) assessed the levels of awareness and acceptance of biotechnology issues among pre-college students, undergraduate students, and other adults. The study found that adults are almost three times more aware of the possible effects of biotechnology on food, health, and even the environment than the younger respondents. The authors concluded that science-based, accessible, and unbiased agricultural biotechnology information from the internet and newspaper impacted the consumer groups. In a study by Vanderschure *et al.* (2010), European high school respondents showed a lack of knowledge about the presence of biotechnology despite its controversies in Europe.

In the Philippines, biotechnology is still young since its establishment two decades ago. Though several studies were conducted during these years on the different applications of biotechnology, its acceptability and understanding is difficult for the general public, especially in the rural areas. This is because of the several factors influencing the decision making which includes balance between cost-effectiveness and risk associated, and doubts in the outcomes of adoption. Other factors include agronomic, socio-cultural, technical, environmental, communication, and information aspects (Scandizzo and Savastano, 2010). Farmer's decision in adopting biotech crops is dependent on yield security and reduced cost of maintenance, which is related to increase in income. In addition, there is a positive correlation between farmers' knowledge and the continued support in the technology (Gonzalvo *et al.*, 2020). Differences between the type of crops among farmer groups has also influenced their decision making. Biotech farmers were mostly influenced by internal factors such as consumer resources while organic farmers rely mostly on external influences such as culture and social interactions (Gonzalvo *et al.*, 2021).

By determining the extent of the public's perception of biotechnology, this paper aims to assess the knowledge, understanding, attitude, and acceptance of biotechnology as being applied to agricultural development and food processing in Southern Cebu, which is a milestone in formulating the best strategies to deliver information effectively.

2 METHODS

Research Design and Conceptual Framework

The purpose of this study was to determine the public's perception, knowledge and understanding towards biotechnology, and the willingness to adopt the technology. It assumed that educational background, which referred to the highest educational level attained, has significant influence in the public's attitude towards biotechnology and its application in agriculture and food processing. The study also identified how the source of information in biotechnology affects the public's judgment in relation to their educational background. By doing cross-comparison between the two factors, a more precise and coherent data on the public's decision-making can be drawn (Fig. 1).

The questionnaire used in this study was adapted from Torres *et al.* (2006). By using the appropriate statistical method (Kruskal-Wallis test), significant relationships between internal response variables were determined. A semi-structured interview schedule was used to gather the respondents' overall perception and knowledge about biotechnology.

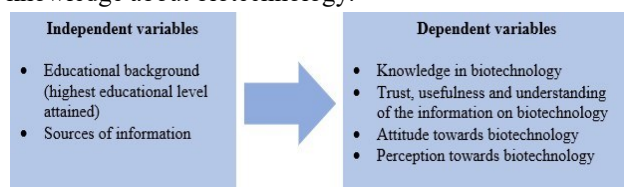


Figure 1. Conceptual framework of the study

estimated population of 3,325,385 as of May 2020, with an annual population growth rate of 2.63% (PSA, 2021).

The criteria for choosing Southern Cebu are as follow:

- There is an existing institution linked to the Biotechnology Center; and
- There is a large agricultural area (since biotechnology in the Philippines is mostly centered in crop improvement)

Representative municipalities were chosen randomly. Samples (n) from 21 (N) municipalities/cities in Southern Cebu were identified at a 90% confidence level and 10% margin of error (e), assuming 30% of the population has knowledge of biotechnology. The sample population was computed using the formula:

$$n = \frac{Z^2 \cdot p(1-p)}{1 + \frac{Z^2 \cdot p(1-p)}{e^2 N}}$$

Overall, 15 municipalities within Southern Cebu were identified, and data were gathered from 257 ± 0.49 (±SEM) respondents.

Scope of the Study and Instrumentation

Respondents were identified based on their highest educational attainment (elementary level, elementary

Table 1. Respondent socio-demographic profile (n=257 ± 0.49).

Socio-demographic Variable	Classification	Number (n) of Respondents					
		Elementary Level	Elementary graduate	High school Level	High school graduate	College Level	College graduate
Gender	Male	13	22	19	21	17	6
	Female	21	29	37	42	18	12
Age	18 to 20	3	1	3	1	3	2
	21 to 30	4	3	6	10	6	4
	31 to 40	10	11	13	19	8	4
	41 to 50	3	13	12	16	10	1
	51 to 60	6	15	14	10	6	4
	61 and above	11	8	6	6	2	3

Project Locale and Sampling

Cebu province is one of the highly industrialized provinces in the Philippines. It is composed of nine cities and 44 municipalities (PSA, 2019), in which 18 municipalities and three-component cities are in the southern part. Agriculture plays a significant role in Southern Cebu for its large farming areas. Cebu province is among the top producers of white corn, sugarcane, cavendish banana, saba banana, mango, cabbage sweet potato, cassava, eggplant, mungbean, peanut, and tomato in the country from 2010-2014 (PSA, 2016). The province, excluding the highly urbanized cities, has an

graduate, high school level, high school graduate, college-level, and college graduate), hence the scope of the study is only limited to their educational background as it influences their perception and decision-making related to biotechnology. Respondents' socio-demographic profile (Table 1), from each municipality, were identified and were categorized based on the category to assume equal distribution.

A Likert scale survey instrument was used in the study. The questionnaire includes both positive and negative items. For items negatively worded, a reversed scoring procedure was used (Usak *et al.*, 2009). The reliability for internal consistency (Table 2) for all the

items in the survey instrument showed excellent results using Cronbach's alpha ($\alpha = 0.906$). However, students are not aware that what they are doing

Table 2. Reliability of subdimension of survey questionnaire using Cronbach's alpha (α).

Aspects/ Parameters	Number of Items	Reliability (Cronbach's α)
Knowledge in Biotechnology and its Application in Food Production	2	0.70
Source of information on biotechnology	12	0.91
Trust in the information on biotechnology	12	0.95
Attitude towards biotechnology	11	0.84
Usefulness of the information on biotechnology in making judgement	12	0.89
Understanding the information on biotechnology	12	0.93
Source, trust, usefulness, understanding	12	0.91
Perception on biotechnology	9	0.62
Opinion, concern and interest in biotechnology concerning public health and safety and agricultural development	5	0.60

Data Gathering

A one-on-one structured interview was used in data gathering and collection. Semi-structured questionnaires were used as a guide in asking questions and information to the respondents. The proponents and enumerators deliberately interviewed individual respondents from October to November 2018, following the ethical standards and the Data Privacy Act of 2012. All respondents were anonymized to protect the individuality of the concerned.

Data Interpretation and Analysis

Data were analyzed using descriptive statistics. Kruskal -Wallis Test, a nonparametric test, was used as test statistics and relatedness of data means, and level of understanding was analyzed using Chi-square Test at $p \leq 0.05$. Other means of analysis were based on the frequency counts, percentage, and weighted means.

3 RESULTS AND DISCUSSION

Knowledge in Biotechnology and its Applications in Food Processing

Knowledge in biotechnology concerning food processing is not well understood within the southern part of Cebu. Table 3 shows that educational background plays a vital role in understanding biotechnology and its processes. The result indicated that college graduate and college level respondents have the highest mean rank at 190.97 and 160.63 respectively. Those who reached elementary level have the lowest mean rank at 78.70. Around 32.7% claimed to have sufficient knowledge in biotechnology (Table 3.1) in which 77.8% of college graduates knew a lot (Table 3.1.1). The same also claimed to have familiarity with its applications in food production (94.40 %) from 26.80 % who knew a lot.

Biotechnology is incorporated into science or biology subjects in elementary schools. This is limited to only traditional biotechnical methods such as the

is already a concept of the technology (Harms, 2002). This reason can be related to why elementary level respondents have a lower score, in terms of knowledge in biotechnology, compared to college graduate and college-level respondents.

Statements were rated by respondents to measure their understanding of biotechnology. Table 4 showed that the respondents' educational background has a significant relationship with the validity of the statements.

Table 3. Respondents' Knowledge in Biotechnology and its Applications in Food Production Based on Educational Background.

	EDUCATIONAL BACKGROUND	Mean Rank
KNOWLEDGE IN BIOTECHNOLOGY	Elementary Level	78.70 ^a
	Elementary Graduate	120.02 ^{abd}
	High School Level	131.59 ^{c-d}
	High School Graduate	123.01 ^{a-d}
	College Level	160.63 ^{b-f}
KNOWLEDGE ON THE USE OF BIOTECHNOLOGY IN FOOD PRODUCTION	College Graduate	190.97 ^f
	Elementary Level	116.88 ^a
	Elementary Graduate	118.39 ^a
	High School Level	119.07 ^a
	High School Graduate	113.36 ^a
College Level	150.73 ^a	
College Graduate	217.56 ^b	

Levels within a column with the same letters are significantly different based on Kruskal-Wallis test (pairwise comparison) at $p \leq 0.05$.

Table 3.1. Frequency Distribution OF Respondents' Response.

	Knowledge in Biotechnology	Knowledge of the use of Biotechnology in food production
Poor	32.3 %	37.4 %
Not too much	35.0 %	35.8 %
Knows a lot	32.7 %	26.8 %

	Knowledge in Biotechnology		Knowledge of the use of biotechnology in food production	
	Highest	Lowest	Highest	Lowest
Poor	60.6 ^a	5.6 ^f	47.1 ^b	0.0 ^f
Not too much	42.9 ^c	16.7 ^f	45.7 ^e	5.6 ^f
Knows a lot	77.8 ^f	3.0 ^a	94.4 ^f	14.3 ^d
<i>a= Elementary level</i>		<i>d= High School graduate</i>		
<i>b= Elementary graduate</i>		<i>e= College level</i>		
<i>c= High School level</i>		<i>f= College graduate</i>		
Total	100.0 %		100.0 %	

Table 3.1.1. Percentage Distribution of Respondents.

Table 4. Understanding Biotechnology in Food Production ($n=257 \pm 0.49$).

STATEMENTS		EDUCATIONAL BACKGROUND						Kruskal-Wallis
		Elementary level	Elementary graduate	High School Level	High School graduate	College level	College graduate	
a. All crops have been genetically modified from their original state thru domestication over a long period.	Mean Rank	134.03	130.46	137.87	120.68	124.84	118.14	3.166
b. Yeast for brewing is consist of living organism.	Mean Rank	122.51	134.04	126.29	131.74	119.16	144.97	2.556
c. Ordinary vegetable does not contain genes while GMO's do. ¹	Mean Rank	180.88 a	143.34 ab	132.00 b	118.22 bc	108.50 bd	58.61 d	43.678*
d. With every new technology, there will always be a potential risk.	Mean Rank	108.38 a	119.61 abc	120.18 abc	129.65 abc	155.71 b	167.78 c	18.131*
e. In genetic engineering, genes of interest are transferred from one organism to another.	Mean Rank	114.09 a	118.17 a	122.96 a	125.39 a	143.86 ab	190.39 b	19.555*
f. Golden Rice contains beta- carotene.	Mean Rank	109.06 a	113.59 a	125.68 ab	128.52 ab	153.69 ab	174.33 b	17.674*
g. Golden Rice can guarantee zero-risk.	Mean Rank	139.68	136.25	117.47	128.42	135.64	106.14	4.639
h. By eating GMO, a process gene could be modified.	Mean Rank	128.87	113.42	126.46	130.74	134.57	141.33	3.376
i. GM products are now being sold in the market.	Mean Rank	120.60 ab	113.64 a	111.94 a	136.48 ab	147.09 ab	172.17 b	18.362*
j. GM crops are now grown in the Philippines.	Mean Rank	135.59	121.61	127.10	129.17	128.93	134.42	1.150
k. Plant viruses are transferred to humans if they eat fruits and vegetables with viruses.	Mean Rank	133.32	112.72	137.85	137.28	122.13	102.36	8.021

Levels within the row with the same letters are significant using Kruskal-Wallis (pairwise comparison) test. Values with an asterisk (*) means there is a significant difference at $p \leq 0.05$.

¹Negatively worded item; a reverse scoring procedure used.

Based on the results, college graduate respondents answered correctly on statements with significant results (c, d, e, f, and i) as determined by the group with a higher score (mean rank). College graduates correctly responded (yes) on the risk associated with new technology (mean rank=167.78), the concept of genetic engineering (mean rank=190.39), and the beta-carotene content of golden rice (mean rank=174.33), and GM

crops available in the Philippine market (mean rank=172.17). In addition, the same person correctly answered (no) on a negatively worded statement, "Ordinary vegetables do not contain genes while GMO's do" (mean rank=58.61).

Similar results were found in the reports of Bal *et al.* (2006) that college students have proper knowledge of biotechnology and genetic engineering. They further emphasized that students who took subjects/courses on genetic engineering can define biotechnology and tell the field's basic concepts. Wnuk & Kozak (2011) have concluded in their study that college students with specialization in the field have greater knowledge of biotechnology and its application to food production.

Recent advancement in biotechnology and the incorporation of the related subjects in the university curriculum might have influenced college graduate respondents' levels of understanding.

Assessing Information on Biotechnology in Making Judgment

Assessing the credibility of the information source is essential in making a judgment on whether the information is reliable or not. Nowadays, print and internet sources vary widely in their authority, accuracy, objectivity, currency, and coverage (Elmer E. Rasmuson Library, 2022). Table 5 showed that educational level affects how the people of Southern Cebu obtained,

trusted, and understood the information on biotechnology. A significant difference ($p \leq 0.05$) was found in each platform and source. Data with no significant difference indicates that the sources of information do not affect the respondents' trust and understanding in making a judgment.

The majority of the college graduates obtained information on biotechnology from seminars, public fora (mean rank=161.31), and books (mean rank=182.64). In addition, the same respondents highly trusted the information sourced from books (mean rank=182.64). Simultaneously, data from mass media, academic institutions, and food regulatory agencies are useful (mean rank=199.06, mean rank=167.42, and mean rank=168.58) in making a judgment.

College-level respondents, on the other hand, have high trust in information coming from the academic institutions (mean rank=157.46), leaflets, brochures and pamphlets (mean rank=151.29), seminars and public fora (mean rank=152.08), and agri-companies (mean rank=153.34). The same respondents have an easy understanding of information coming from the religious figures (mean rank=146.53), academic institutions (mean rank=154.77), internet (mean rank=149.43), books (mean rank=162.03), and agri-companies (mean rank=153.34). The study of Wingenbach and Rutherford (2005) supported the result by concluding that university scientists'/researchers' information is trustworthy.

High school graduates highly trusted the information relayed by their family, friends, neighbors, and coworkers (mean rank=147.94) and sourced from the internet (mean rank=146.08). While respondents at the high school level primarily sourced the information from food regulatory agencies (mean rank=147.39) and agri-companies (mean rank=146.44). A previous study linked student trust to both behavior and academic outcomes, such that there is a relationship between student trust, behavior, and high school outcomes. Students who showed more trust in their schools have better high school outcomes (Romero, 2015). In addition, students do not trust people whom they do not know, other than their family and close friends (Akbas, 2012).

Elementary graduates sourced the information conveyed by their family, friends, neighbors, and officemate (mean rank=145.04) and easily understood the information coming from mass media (mean rank=150.73) while elementary level highly trusted the source from religious figures (mean rank=158.63) and found useful information from their family, friends, neighbors, and officemate (mean rank=160.41) and the internet (mean rank=154.35). The same respondents have an easy understanding of the information from leaflets, brochures, and pamphlets (mean rank=145.59).

Lamauskas & Makarskaite-Petkeviciene (2008) stated that the knowledge and information related to biotechnology were discussed in general education. The

result showed that the respondents have a variable preference for the source of information on biotechnology. The study by Aleksejeva (2014) found that the internet is the major source of information on biotechnology (77.4%), followed by television (63.6%), relatives and friends (54.5%), radio (36.4%), newspapers and magazines (22.7%), and scientific papers (13.6%). While in this study, high school graduates highly trusted the information on biotechnology coming from the internet. Similar results were found by Turker *et al.* (2013), in which 21.7% of the respondents sourced their information from the Internet. This is because the internet is considered an ocean of information with a constantly growing communication network (Lee, 1996). Although the internet holds a vast amount of information on biotechnology, college-level, and college graduate respondents have little trust in the source. Instead, the result showed that they highly trusted the information from scientific sources (academe/researchers, books, and seminars). Chen & Wu (2020) obtained a significantly lower trust of college students in online information, related to health and science. They also found a relationship between their trust and the fields they specialized in. In addition, college students rely on academic journals from the internet more compared to either newspapers or magazines (Metzger *et al.*, 2003).

Attitude Towards Biotechnology

Biotechnology being new to the public is believed to greatly impact society and requires informed decision-making and critical attitudes toward the field (Klop & Severiens, 2007). Table 4-6 showed four statements (b, h, j, and k) with significant results. These statements greatly impact the respondents' critical decision-making and acceptability of biotechnology.

College level and college graduate respondents have a high positive response towards the statements, and they agreed to attend seminars regarding biotechnology (mean rank=151.66 and mean rank=141.31), that the public should be consulted on formulating food regulations and laws (mean rank=150.77 and mean rank=146.81), and that research and development in biotechnology should be presented to the public (mean rank=151.69 and mean rank=206.22). However, college-level and college graduate respondents disagreed that modern biotechnology regulation should be left mainly to the industry (mean rank=110.86 and mean rank=99.11), which is contrary to the elementary-level respondents who highly agreed with the statement (mean rank=157.29). College level and college graduate respondents tend to involve themselves in the policy-making related to biotechnology. The reason for this can be related to the volume of information in biotechnology that is mostly taught in universities and colleges.

Table 5. Source, trust, usefulness and understanding of the information on biotechnology in making a judgment (n=257).

SOURCES OF INFORMATION	EDUCATIONAL BACKGROUND							Kruskal-Wallis	
	Elementary	Elementary	High School	High School	College	College			
	level	graduate	Level	graduate	level	graduate			
<i>Mass media (TV, newspaper, radio)</i>	Source	Mean Rank	138.46	119.30	147.21	113.70	133.30	127.14	9.109
	Trust	Mean Rank	137.69	121.09	111.59	141.40	137.43	129.36	6.886
	Usefulness	Mean Rank	115.59 a	106.95 a	108.61 a	132.76 ac	163.99 ac	199.06 b	42.883*
	Understanding	Mean Rank	143.29 ab	150.73 a	110.23 b	116.33 ab	135.81 ab	129.92 ab	13.179*
<i>Family, friends, neighbor and officemate</i>	Source	Mean Rank	139.03 ab	145.04 a	136.86 ab	109.68 b	116.63 ab	131.83 ab	12.683*
	Trust	Mean Rank	134.82	139.15	116.38	147.94	107.10	104.81	12.797*
	Usefulness	Mean Rank	160.41 a	126.22 ab	123.04 ab	132.75 ab	119.06 ab	102.33 b	12.632*
	Understanding	Mean Rank	133.54	129.23	121.26	139.91	121.09	121.06	3.035
<i>Religious figures</i>	Source	Mean Rank	110.53	126.91	136.64	128.48	135.10	136.00	7.094
	Trust	Mean Rank	158.63 a	142.74 ab	114.36 ab	139.07 ab	104.86 b	91.36 b	20.632*
	Usefulness	Mean Rank	130.53	132.37	126.54	137.48	124.73	102.85	4.219
	Understanding	Mean Rank	135.00	137.82	102.99	135.86	146.53	115.50	12.296*
<i>Academe/ Researchers</i>	Source	Mean Rank	113.18	121.44	140.60	124.59	141.60	135.17	8.739
	Trust	Mean Rank	137.12 ab	132.02 ab	108.53 a	116.60 ab	157.46 b	156.89 ab	16.304*
	Usefulness	Mean Rank	120.79	116.86	120.01	129.23	148.87	167.42	12.516*
	Understanding	Mean Rank	103.59 ac	133.78 abc	103.68 a	142.30 cd	154.77 bd	145.56 abc	21.481*
<i>NGOs</i>	Source	Mean Rank	120.72	121.40	142.22	122.74	143.20	119.33	9.158
	Trust	Mean Rank	123.12	124.03	121.09	134.01	147.53	125.25	4.117
	Usefulness	Mean Rank	138.37	124.19	107.88	136.67	141.71	139.08	8.695
	Understanding	Mean Rank	148.03	129.59	107.08	131.25	140.30	122.24	9.785
<i>LGU</i>	Source	Mean Rank	120.59	121.26	140.72	122.60	142.93	119.22	7.981
	Trust	Mean Rank	126.25	121.92	115.24	137.73	145.11	135.17	5.708
	Usefulness	Mean Rank	130.91	138.84	117.54	130.30	126.67	133.11	2.831
	Understanding	Mean Rank	141.32	136.94	119.63	123.48	135.63	110.71	5.000
<i>Internet</i>	Source	Mean Rank	118.96	122.52	138.81	121.72	146.26	127.72	8.384
	Trust	Mean Rank	133.82 ab	133.49 ab	125.70 ab	146.08 a	113.10 ab	88.58 b	11.957*
	Usefulness	Mean Rank	154.35 a	122.92 ab	134.11 ab	134.05 ab	104.31 b	112.78 ab	11.260*
	Understanding	Mean Rank	108.60	140.84	106.25	132.65	149.53	145.88	14.667*
<i>Books</i>	Source	Mean Rank	124.12	124.95	135.80	120.40	138.51	140.14	7.671
	Trust	Mean Rank	117.44 a	119.70 a	111.46 a	132.47 ab	148.20 ab	182.64 b	18.510*
	Usefulness	Mean Rank	120.94	121.87	114.47	137.88	140.46	156.25	8.622
	Understanding	Mean Rank	93.12 a	126.14 ab	106.08 a	147.14 b	162.03 b	148.47 ab	29.943*
<i>Leaflets, brochures, pamphlets</i>	Source	Mean Rank	118.66	124.76	131.08	127.06	137.53	144.28	7.298
	Trust	Mean Rank	117.46 a	129.79ab	106.44 ab	138.89 ab	151.2 9 b	140.81 ab	12.149*
	Usefulness	Mean Rank	127.81	136.99	126.47	118.92	127.87	153.94	4.882
	Understanding	Mean Rank	145.59 a	135.94 ab	103.61 b	137.63 ab	133.86 ab	117.33 ab	13.608*
<i>Food regulatory agency</i>	Source	Mean Rank	119.50	121.35	147.39	118.63	134.79	136.42	15.139*
	Trust	Mean Rank	124.84	125.68	113.31	138.29	146.20	129.14	6.211
	Usefulness	Mean Rank	116.90	120.42	115.04	134.36	145.60	168.58	12.547*
	Understanding	Mean Rank	120.53	133.53	115.18	136.39	140.76	126.44	4.918
<i>Seminars and Public fora</i>	Source	Mean Rank	112.72 ab	121.93 ab	145.33 bc	116.33 a	132.10 abc	167.31 c	22.673*
	Trust	Mean Rank	117.31	121.51	110.96	140.11	152.89	143.08	11.626*
	Usefulness	Mean Rank	124.56	128.94	122.98	131.30	131.29	143.78	1.614
	Understanding	Mean Rank	126.78 ab	125.96 ab	105.77 a	137.08 ab	152.08 b	140.86 ab	12.723*
<i>Agri. companies</i>	Source	Mean Rank	112.47 a	121.61 ab	146.44 b	118.94 a	138.99 ab	142.72 ab	18.900*
	Trust	Mean Rank	123.10	120.91	109.47	140.75	153.34	135.33	11.544*
	Usefulness	Mean Rank	125.74	124.51	138.57	127.62	128.63	123.67	1.501
	Understanding	Mean Rank	134.06	128.50	111.96	137.72	133.91	133.78	5.201

Levels within the row with the same letters are significant using Kruskal-Wallis (pairwise comparison) test. Values with an asterisk (*) mean there is a significant difference at $p \leq 0.05$.

Table 6. Attitude Towards Agricultural Biotechnology

STATEMENTS		EDUCATIONAL BACKGROUND						Kruskal-Wallis
		Elementary level	Elementary graduate	High School Level	High School graduate	College level	College graduate	
a. The use of biotechnology in food is against my moral values.	Mean Rank	127.15	114.23	136.38	137.21	142.56	124.42	4.376
b. If my community would hold an information session on biotechnology, I would attend.	Mean Rank	94.75 a	128.13 ab	118.72 ab	141.22 b	151.66 b	141.31 ab	14.903*
c. Foods genetically altered should be labeled.	Mean Rank	112.28	133.46	115.46	131.66	145.30	148.92	7.544
d. Genetic manipulation is against the will of God.	Mean Rank	106.34	137.99	141.18	124.25	131.33	120.56	6.349
e. Until we know that GM foods are totally safe, these products should be banned.	Mean Rank	119.93	124.54	113.83	145.92	132.13	140.67	7.571
f. We have no business meddling with nature.	Mean Rank	124.99	128.72	122.49	135.25	134.36	125.36	1.306
g. I am willing to pay extra cost for non-GMO food (proper labeling).	Mean Rank	131.54	119.13	114.51	141.94	136.10	138.14	5.859
h. Modern biotechnology regulation should be left mainly to the industry.	Mean Rank	157.29	129.66	144.01	118.48	110.86	99.11	14.294*
i. I would contribute my time to an organization that bans GM foods.	Mean Rank	127.97	122.15	116.32	140.79	128.43	149.64	5.280
j. The public should be consulted on formulating food regulations and laws.	Mean Rank	110.93	118.12	112.29	145.24	150.77	146.81	15.089*
k. Research and development in biotechnology should be presented to the public.	Mean Rank	97.43 a	131.47 ab	108.29 ab	127.79 ab	151.69 bc	206.22 c	37.593*

Levels within the row with the same letters are significant using Kruskal-Wallis (pairwise comparison) test. Values with * means there is a significant difference at $p \leq 0.05$.

Detailed information on biotechnology is being taught in college as it is incorporated into the course subject. College classification level has a favorable view of biotechnology and this significantly influences their attitude towards the technology (Sohan *et al.*, 2002).

Higher educational background and knowledge in biotechnology can influence the public's attitude and acceptance of the field. The study of Usak *et al.* (2009) revealed that respondents coming from the university showed significantly higher positive attitudes toward spending and consuming genetically modified products compared to high school respondents. Bahri *et al.* (2014) found a moderate level of Malaysian respondents' attitude toward biotechnology relate to the lack of exposure to products and biotechnology applications in their everyday lives. The same result was obtained by the previous study by Subahan *et al.* (2012) on Malaysian

High School students' attitudes toward shopping and consuming genetically modified products.

In the study by Torres *et al.* (2006), 63.7% of the Filipino stakeholders are willing to attend an information session related to biotechnology, regardless of their educational background. In the same study, 74.3% of the scientists disagreed with the statement that modern biotechnology regulation should be left mainly to the industry. This means that people with a background in science are more willing to participate in policy-making related to biotechnology.

The positive public attitude on biotechnology is dependent on the typical benefits it contributes to the community and the environment upon its application. Moreover, knowledge and information are also crucial in obtaining a good level of attitude and acceptability by the public (Aerni, 2002; Klop *et al.*, 2010).

Perception towards Agricultural Biotechnology

Public perception of biotechnology can be assessed in many ways. Barriers, which hinder the overall progress towards the solution, have been identified between the technology and the public. Such barriers are agreement, knowledge, technology, economic, social, and political (AKTESP), which is based on Trudgill's Framework for Analysis (Lim *et al.*, 2009). However, Amin *et al.* (2011) s doubted and disagreed with this analysis since a complex emerging issue, such as modern biotechnology, should be a multi-dimensional construct.

This study used a multi-directional approach to

regulation of GM food should be developed together with NGOs (mean rank=174.64). On the other hand, they disagreed with the statement regarding unexpected new allergens and other public health threats associated with GM food products (mean rank=68.33) compared to the elementary level, who highly agreed with the statement (mean rank=152.85). The result indicates that higher educational attainment has significant effects and influences on the acceptability and perception of biotechnology.

Previous studies supported the significantly higher result for statements f and h where the majority of the Filipino respondents agreed. On the other hand, most

Table 7. Perception on Agricultural Biotechnology.

STATEMENTS		EDUCATIONAL BACKGROUND						Kruskal - Wallis
		Elementary level	Elementary graduate	High School level	High School graduate	College level	College graduate	
a. The government is doing its best to ensure the food we eat is safe.	Mean Rank	121.91	115.41	118.11	138.00	135.12	137.83	4.883
b. Biotechnology only benefits large agricultural companies.	Mean Rank	144.26	132.89	118.43	129.37	110.21	122.17	5.350
c. Government regulatory agencies have the scientific and technical information they use in order to make good decisions about biotechnology in food.	Mean Rank	139.53	129.19	109.68	125.34	137.32	123.72	5.438
d. Vital information about the health effects of GM food is being held back.	Mean Rank	129.56	134.47	118.14	127.80	123.94	131.97	1.681
e. The risk of GM food has been greatly exaggerated.	Mean Rank	135.36 a	108.53 a	108.41 a	120.65 a	140.68 a	210.17 b	34.668*
f. Biotechnology is good for Philippine agriculture.	Mean Rank	145.47 b	124.18 ab	92.23 a	111.77 a	160.53 b	169.22 b	34.226*
g. Current regulations in the Philippines are sufficient to protect people from the risk linked to modern biotechnology.	Mean Rank	145.02	124.53	115.55	116.13	130.70	152.11	7.652
h. Regulation on GM food should be developed together with NGOs.	Mean Rank	107.59 ac	101.74 a	131.55 ab	141.98 bc	120.87 ab	174.64 b	22.01*
i. GM food products could create unexpected new allergens resulting to public health threats.	Mean Rank	152.85 b	131.34 b	127.19 b	120.04 ab	130.84 b	68.33 a	17.870*

Levels within the row with the same letters are significant using Kruskal-Wallis (pairwise comparison) test. Values with * means there is a significant difference at $p \leq 0.05$.

tracing public perception, awareness, and belief toward agricultural biotechnology among educational levels. Significant figures were found in four statements, e, f, h, and i, among respondents' levels of education, indicating the level effect on the public perception. The result statistically revealed that college graduates (Table 7) highly agreed that the risk of GM food is greatly exaggerated (mean rank=210.17), biotechnology is good for Philippine agriculture (mean rank=169.22), and the

scientists agreed that the risk of GM food had been greatly exaggerated. While around half agreed that GM food could trigger new allergens, indicating that the knowledge gap on genetic engineering consequences is still present and must be filled through deliberate education and information dissemination (Torres *et al.*, 2006).

Perceived Risk/Hazard Oriented with Biotechnology

in Food Production

The educational attainment of respondents has significant effects on perceived hazards related to biotechnology in food production (Table 8). This means that the potential hazards in biotechnology have a very high impact on the public's beliefs and opinions. Elementary graduates and elementary-level respondents perceived high-risk involving biotechnology in food production. Out of 24.1% who agreed that it is very hazardous (Table 8.1), 35.3% of the respondents reached elementary level while college-level respondents did not perceive this as hazardous (mean rank=89.82; percentage=40.00%).

Involvement of Science on Biotechnology Concerning Public Health Safety and Agricultural Development

The majority of the high school graduate respondents (mean rank=149.70) are very concerned about the involvement of biotechnology in public health, while college graduate respondents (mean rank=121.64) are less and/or not concerned at all (Table 9). In addition, college graduate respondents (mean rank=163.58) favor science as part of the agricultural development in the Philippines, while high school level respondents (mean rank=100.63) agreed that it is not. In terms of the use of agricultural biotechnology, elementary-level respondents (mean rank=145.94) are very concerned about the

Table 8. Perceived risk/hazard oriented with biotechnology in food production.

EDUCATIONAL BACKGROUND	Mean Rank	Kruskal- Wallis
Elementary Level	133.23	
Elementary Graduate	134.01	
High School Level	131.24	14.688 *
High School Graduate	124.51	
College Level	89.82	
College Graduate	91.94	

Kruskal-Wallis value with * means there is a significant difference at $p \leq 0.05$.

Table 8.1. Percentage distribution table on perceived risk/hazard oriented with biotechnology in food production.

	Highest	Lowest	Percent
Not at all hazardous	40.0 ^e	16.7 ^f	21.0
No opinion	38.9 ^f	11.1 ^d	20.6
Somewhat hazardous	39.3 ^c	26.5 ^a	34.2
Very hazardous	35.3 ^a	0.00 ^f	24.1
	TOTAL		100.0

a=Elementary level

b= Elementary graduate

c= High School level

d= High School graduate

e= College level

f= College graduate

Cavanagh *et al.* (2005) found that 73.8% of respondents from higher educational levels in New South Wales, Australia believed that biotechnology's potential benefits outweigh the risk. Similarly, 70-75% of Spanish people, regardless of their educational background, have positive acceptance and approval of the commercialization of GM crops and fermented foods. Only around 17% thought GM foods were less safe than non-GM foods (Ramón *et al.*, 2008). In contrast, 78.5% of Chinese supported that GM food has an unknown risk to human health, which affected human beings for many generations (Cui & Shoemaker, 2018). Likewise, around 49.3% of Filipinos believed that agricultural biotechnology in food production was somewhat hazardous. In comparison, 30.7% supported no hazards in incorporating agricultural biotechnology in food production (Torres *et al.*, 2006).

involvement of biotechnology. Those who reached college level (mean rank=99.91) and college graduate (mean rank=96.28) respondents were not concerned at all. However, significant results were not found in their interest in the use of agri-biotech in food production.

Previous reports found that the majority (48.6%) of the Filipinos with educational knowledge in biotechnology are somewhat concerned about biotechnology's involvement in public health and safety and only 17.1% are not at all concerned. However, they agreed (85.7%) that science should be part of agricultural development, while 54.3% are concerned about using agricultural biotechnology (Torres *et al.*, 2006).

Wingenbach & Rutherford (2005) reported higher concerned respondents about the consequence of agricultural biotechnology on farming and food production, followed by the relatively lower levels of

public knowledge and human health risks and safety concerns.

human health concerns, environmental concerns, and ethical concerns, which do not lie in the product's characteristics but rather the way it is made. The public's

Table 9. Respondents' opinion, concern and interest in biotechnology concerning public health and safety and agricultural development.

STATEMENTS		EDUCATIONAL BACKGROUND					Kruskal-Wallis	
		Elementary level	Elementary graduate	High School Level	High School graduate	College level		College graduate
<i>Perceived involvement of biotechnology in public health.</i>	Mean Rank	138.57 ab	122.60 ab	119.52 ab	149.70 a	104.61 b	121.64 ab	11.708*
<i>Extent that science should be part of agricultural development in the Philippines.</i>	Mean Rank	115.40 ab	120.88 ab	100.63 a	142.33 b	148.09 b	163.58 b	21.160*
<i>Interest in the use of agri-biotech in food production.</i>	Mean Rank	140.93	126.79	104.25	134.60	129.85	139.67	8.837
<i>Concern on the use of agricultural biotechnology.</i>	Mean Rank	145.94	142.80	129.57	127.11	99.91	96.28	14.153*

Levels within the row with the same letters are significant using Kruskal-Wallis (pairwise comparison) test. Values with * means there is a significant difference at $p \leq 0.05$.

Issues on Biotechnology

Some of those who are not in favor of biotechnology see it as unethical to question the power of man to alter creation, and that genetic manipulation is against the teachings of the church and culture of man. The beliefs on where these issues must fall were deliberately tabulated and shown in Table 10.

view in choosing an ethical category for concerns in biotechnology, followed by cultural considerations, is mainly influenced by their judgment while politics is least impacted (ISAAA-UIUC, 2003; Amin *et al.*, 2011; Panopio & Navarro, 2011). In a conservative country like the Philippines, biotechnology's principal challenge generally falls under moral/ethical issues other than

Table 10. Percentage distribution table on the issues where biotechnology must fall.

	Highest	Lowest	Percent
Cultural	88.9 f	47.6 d	59.5
Moral/ ethical	25.5 b	5.6 f	20.6
Religious	26.5 a	5.6 f	14.8
Other	9.5 d	0.0 e,f	3.5
	TOTAL		98.4
Not answered			1.6

a=Elementary level

b= Elementary graduate

c= High School level

The majority of the respondents identified these issues as cultural or traditional beliefs (59.5 %). Moreover, 89.9 % of them are college graduates, while 47.6 % (lowest) are high school graduates. On the other hand, 20.6 % agreed that these should be an ethical issue, where 25.5 % are elementary graduates. Out of 14.8 % who agreed that it should be under religious issue, 26.5 % reached the elementary level. Only 3.5 % pointed out that there are other categories for these issues such as health, environment, and politics.

The public's issues and concerns towards the product of modern biotechnology are categorized based on

d= High School graduate

e= College level

f= College graduate

technical reliability and utility (Torres *et al.*, 2006; APAARI, 2019). While in this study, Southern Cebu perceived biotechnology as a cultural concern, rather than moral/ethical. Susumu (2011) discussed this issue concerning human embryos used in research in most western countries, connecting the conflict to ethics and morals over family and culture. The conflict was deduced as those in favor of the traditional cultural ideals hold opposing views, while those in favor of social reform are morally lenient.

4 CONCLUSIONS AND RECOMMENDATION

While biotechnology has been used since the ancestral time, public understanding and knowledge have not been well-established since this term was just used in recent decades. This study showed significant results highlighting levels of education influencing the public's perception and awareness of biotechnology. Based on the evidence, college graduates are more aware and knowledgeable about biotechnology and its uses in food production. In addition, the same group of respondents, together with those who reached college level, highly trusted information coming from scientific sources such as the academe/researchers, books, seminars, and forums compared to elementary level and elementary graduates who highly trusted and read information from acquaintances, religious figures, and the internet. Respondents at college level and college graduates also have a positive attitude and perception towards biotechnology and are willing to attend seminars and take involvement in policy making regarding biotechnology. Furthermore, the same respondents perceived no harm and are less concerned with biotechnology in food production and agricultural development. They also believed that science should be part of agricultural development in the Philippines. The study also revealed that biotechnology is a cultural concern in Southern Cebu rather than ethical/moral, religious, health, environmental and political. Thus, this study further revealed that those who have a higher level of education have better knowledge and understanding of biotechnology and its application in food production, public health and safety, and agricultural development.

Based on how lower educational background respondents perceived biotechnology, this study recommends that the government and non-government sectors, including the LGU and universities, should improve the mode of information delivery to a simpler but comprehensive, in a way that the public can understand. Moreover, proper education and seminars on the use of technology generated from biotechnology must also be done to increase the public's willingness to accept the technology. Delivery of information and communication-related biotechnology should focus on addressing the incorrect public perceptions, especially those with lower educational backgrounds, to avoid misconceptions of the technology.

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