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PROTEIN PREFERENCES UNVEILED: A COMPARATIVE STUDY OF DIETARY CHOICES IN SHANGHAI AND AMSTERDAM

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Abstract: *Developing countries are witnessing a nutritional and economic transformation marked by a shift from plant-based protein to animal-based protein consumption. This transition, driven primarily by rising incomes, carries significant environmental and sustainability implications. While it is widely recognized that the growing consumption of animal-based protein is unsustainable and detrimental to natural ecosystems, climate stability, and resource usage, the choice of animal protein source is influenced by a complex interplay of factors including governmental policies, cultural norms, and religious beliefs. This paper delves into the challenges posed by the increasing production and consumption of animal-based proteins, emphasizing their adverse environmental impact. The production of animal proteins demands more resources, such as freshwater and energy, per gram compared to plant-based proteins. Moreover, it results in higher greenhouse gas emissions, exacerbating global warming and climate change concerns.*

In contrast, developed countries are now promoting a reverse protein transition: a shift from animal proteins to plant proteins. This paper sheds light on this emerging trend, highlighting its potential to mitigate the environmental consequences associated with protein production and consumption.

Keywords: *Protein transition, Sustainable nutrition, Environmental impact, Plant-based protein, Animal-based protein.*

1. Introduction

Developing countries are undergoing economic and nutritional transformation. Traditionally, as incomes increase and people experience more prosperity, the proteins in their diets that were previously derived from cereal crops and other plant-based sources, are gradually replaced by proteins from animal products (Gouel & Guimbard, 2018). This trend in transition is from plant protein to animal protein, and it has been identified as a form of protein transition. Although this transition is considered to be income-driven, the choice of animal protein (meat, fish, or dairy products) may also depend on other factors as governmental policy, religion, and other social and cultural variables (Drewnowski & Poulain, 2018).

Many studies have shown that the increase in animal protein production and consumption is unsustainable. It has already lead to degradation of natural systems, global warming and

other forms of climate change (Green et al., 2007). The production of protein from animal sources is more harmful to the environment because more inputs, like fresh water and energy, are required per gram for their production than that which is needed for plant-based protein (Witte et al., 2021). Likewise, output of greenhouse gasses, as expressed in CO_2 equivalents, is considerably higher from the production of animal proteins than from plant proteins (Lonnie & Johnstone, 2020). For that reason, in developed countries, a new form of protein transition is being promoted, that is: from animal protein to plant protein.

To study these changes in protein transition, young adults aged 20-35 were chosen as the target group for the survey. This is because people in this age group represent the future educated labor force, they will become the biggest influencers in technology development and in consumer behavior.

The objective of this research was to investigate with regard to trends in protein transition the differences in the diet of young adults between China (Shanghai) and The Netherlands (Amsterdam) by means of a field study of 200 questionnaires in both regions. The impact of five main driving forces on the transition trends will be discussed.

2. Materials and Methods

2.1 Study design

Based on information from literature (Gouel & Guimbard, 2018; Drewnowski & Poulain, 2018; Lonnie & Johnstone, 2020), a questionnaire was designed that could shed more light on the preferences of young adults with respect to their preferred food choice and how this changed over a period of time. The driving forces taken into consideration were: environmental awareness; policy; culture (religions); money; and health. The questionnaire asked the respondents about the type of food they ate five years ago, at present and what they planned to eat in the coming year. Validity of the answers was checked by the inclusion of repeated questions that were slightly differently formulated in different places within the questionnaire. The questionnaire was provided in Chinese, English or Dutch. The English version is provided as supplemental material (Supplement 2).

The questionnaire for Shanghai respondents was released on the platform Questionnaire star. The questionnaire for Amsterdam (The Randstad) respondents was released on the platform Google Form. The age group was set between 20-35 years old. Of the 202 questionnaires that were returned from the Shanghai cohort, two were discarded due to apparent non-serious and non-consistent answers.

2.2 Statistics

The software package SPSS version IBM SPSS 24 was used for statistical analysis of the data. Because the data collected in the survey was typically of categorical nature, the analysis was based on Chi-square test. The resulted P-values smaller than or equal to 0.05 were considered as significant.

3. Results

From each area, Shanghai and Amsterdam, 200 respondents returned their answers to our questionnaire about the type of food they ate five years ago, at present and what they planned to eat in the coming year. A summary of the obtained results is given in Figure 1, including the hypotheses made for the different groups based on environmental awareness, government advocacy and policy, religion, and economic condition. It can be seen that in most cases, the diet of Shanghai respondents had not

changed significantly over time. On the contrary, Amsterdam young adults in most cases had made very significant changes in their diets over time.

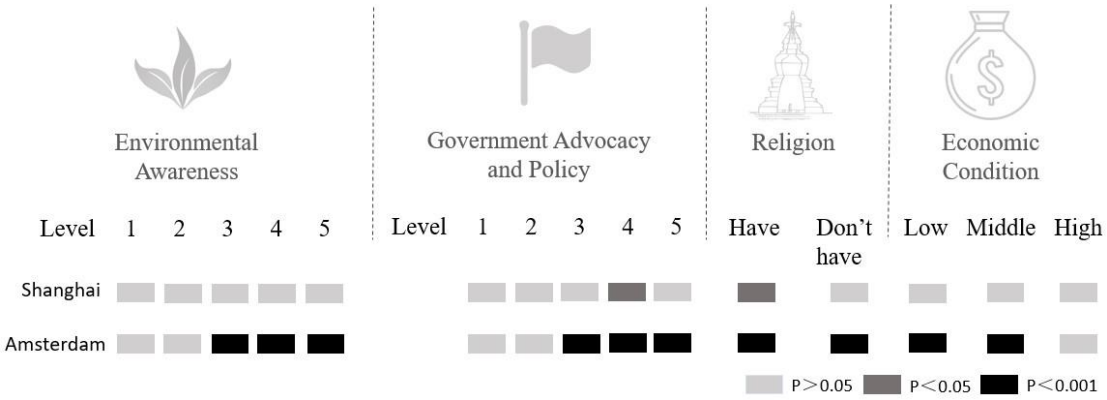

Figure 1. Differences in dietary preferences of respondents in Shanghai and Amsterdam over time. With respect to environmental awareness and government policy respondents were divided into five levels (see Table 1 and 2). For Shanghai, no differences in the distribution of dietary choices were found over time, with one exception. For government advocacy and policy Shanghai group 4 (care a lot about policy) indicated random choices five years ago but diets with half animal protein and half plant-based protein at present and in the future. In Amsterdam, groups 3, 4 & 5 significantly preferred more plant-based protein over time. With respect to religion all groups showed a difference in dietary preference over time except the non-religious group in Shanghai. With respect to economic condition the groups in Shanghai showed no difference between dietary choices over time, but in the three income groups in each time period more people chose a balanced diet (of meat and vegetables) than plant-based diets. In Amsterdam the low-income and middle-income groups chose to reduce animal protein diets and increase plant-based protein diets. Significant differences based on chi-square testing are indicated in black ($p<0.001$) and dark grey ($p<0.05$), n=200 for each region.

The environmental concerns of Shanghai respondents were not evenly distributed, the number of people with moderate concerns and above was relatively large. More than 70% of Amsterdam respondents attached great importance to the environment (Table 1). The degree of environmental concern of the Amsterdam respondents was higher than that of the Shanghai respondents.

Table 1. Distribution of environmental awareness level of respondents in Shanghai and Amsterdam

	Environmental awareness level					x^2(df)	p
	Totally don't care (n)	Care a little (n)	Care intermediately (n)	Care a lot (n)	Fully care(n)		
Shanghai	5.0%(10)	17.0%(34)	32.0%(64)	36.5%(73)	9.5%(19)	76.050(4)	0.0005
Amsterdam	1.0%(2)	5.0%(10)	10.5%(21)	61.0%(122)	22.5%(45)	236.350(4)	0.0005

n=number of respondents; df = degrees of freedom

Based on the questionnaire results (Supplemental Table 1), the environmental awareness level has little effect on the dietary choices of Shanghai respondents. However, in Amsterdam, respondents who paid

more attention to the environment were also eager to eat more plant-based protein diets in the future than 5 years ago.

The policy concerns of Shanghai respondents were unevenly distributed. The level of the majority are moderate concerns and above. More than half of the respondents in Amsterdam cared a lot about policy (Table 2). The degree of policy concern of the Shanghai respondents was found to be lower than that of the Amsterdam respondents.

Table 2. Distribution of policy awareness level of respondents in Shanghai and Amsterdam

	Policy awareness level					x^2(df)	p
	Totally don't care (n)	Care a little (n)	Care intermediately (n)	Care a lot (n)	Fully care(n)		
Shanghai	11.0%(22)	20.0%(40)	32.5%(65)	29.0%(58)	7.5%(15)	47.450(4)	0.0005
Amsterdam	3.0%(6)	9.0%(18)	27.5%(55)	46.0%(92)	14.5%(29)	117.250(4)	0.0005

n=number of respondents; df = degrees of freedom

From the questionnaire results (Supplemental Table 2), Shanghai young adults who cared a lot about policy seemed to show different behaviors than the other groups. They changed their minds over time and indicated to consume more plant-based protein than animal protein. Similar as the situation in environmental awareness factor, Amsterdam respondents who focused more on policy showed over time to be more eager to choose diets with plant-based protein.

As shown in Table 3, there were five factors given in the survey for respondents to rank. Each factor had to be selected and could only be selected once. The rankings, from 1st to 5th, were from the most influential to the least influential (in the opinion of the respondents). Based on the five factors, there is a difference in the number of people between Shanghai respondents and Amsterdam respondents regarding the ranking of environmental awareness, policy, culture and health factors. For substantiation of Table 3 see Supplemental Tables 3.

Table 3. Differences in the ranking of the degree of influence of money, environmental awareness, health, cultural, and policy factors on young adults in Shanghai and Amsterdam

factor		number of people					comprehensive score	rank
		rank 1st	rank 2nd	rank 3rd	rank 4th	rank 5th		
environmental awareness	Sh.	51	39	54	34	22	3.315	2
	Am.	38	64	53	38	7	3.440	2
policy	Sh.	10	51	34	64	41	2.625	5
	Am.	6	20	55	66	53	2.300	4
culture	Sh.	38	29	44	43	46	2.850	4
	Am.	10	21	19	48	102	1.945	5
money	Sh.	56	46	34	30	34	3.300	1
	Am.	63	36	38	31	32	3.335	3
health	Sh.	45	35	34	29	57	2.910	3
	Am.	83	59	35	17	6	3.980	1

Sh.=Shanghai; Am.= Amsterdam

Ranking from high to low:

- Shanghai --- Money＞ Environmental awareness＞ Health＞ Culture＞ Policy
- Amsterdam --- Health＞ Environmental awareness＞ Money＞ Policy＞ Culture

4. Discussion

Proteins can be divided into animal protein and plant-based protein. Protein transition refers to the two types of direction of change (Witte et al., 2021; Drewnowski & Popkin, 1997; Manners et al., 2020). The traditional transition driven by economic development is one from plant-based protein consumption towards animal protein consumption. The other form of transition is from animal protein consumption towards the consumption of plant proteins. From a global perspective, the trend of protein transition in developing countries is the former one, and the trend of protein transition in developed countries is now the latter (Gouel & Guimbard, 2018; Witte et al., 2021). According to our research results, there is a difference in diet trends of protein transition among young adults in China (Shanghai) compared with those in The Netherlands (Amsterdam).

4.1 Environmental awareness

Most Shanghai residents indicated that they would actively cooperate with environmental protection policies and participate in environmental protection activities. In terms of diet, they would also pay more attention to whether the food is sustainable and if it pollutes the environment (Yan et al., 2012; Kong et al., 2014). Shanghai residents have a strong sense of environmental protection, and there are policies related to plant-based protein foods (Mao et al, 2015). However, much still needs to be done in education related to environmental protection in schools, communities and in companies.

The unsustainability of protein sourced from animal products (Manners et al., 2020) has led some people in Amsterdam to call for the encouragement of a sustainable diet rich in plant-based protein. A _meatless challenge 'has also surfaced within the food sector (de Boer et al., 2014). Its main purpose is to reduce the consumption of mass scale produced meat and promote vegetarianism. Amsterdam is a city that focuses on sustainable development. Most residents are environmentally conscious and pay attention to health issues. Environmental awareness factors have a great impact on the dietary choices of young adults in Amsterdam.

4.2 Government advocacy and policy

On December 25, 2020, the Chinese Society for Food Science and Technology issued the group standard for _Plant-based Meat Products '. The relevant participants include universities and scientific research institutions, as well as enterprises involved in supply of raw materials, processing and sales (Mao et al, 2015). From this initiative a national standard was established. This action of the Chinese government aims to call on more companies to devote themselves to the manufacture of plant-based protein products.

Amsterdam announced a plan to provide vegetarian food in catering activities in urban buildings by default from 2020. Unless participants specifically request meat or fish, all meetings within the capital city will be vegetarian food (Aczel, 2021).

The impact of the policy factor on young adults in Amsterdam was greater than that on young adults in Shanghai. The attitudes of consumers in Shanghai towards animal-based products remain unchanged

and this may be one reason (Ritchie et al., 2018). To reduce the consumption of animal products, there is a need to increase the acceptance of plant-based meat substitutes.

4.3 Culture/religion

Buddhism (Ghosh, 2020), Taoism (Juhasz, 2021), Islam (The Pen Magazine, 2021), Christianity (Li, 2017), Hinduism (NHS, 2021) and Judaism (BBC,2021) are six mainstream religions in the East and the West. They have many similarities in diet. Most of the foods taken are rich in anti-disease antioxidants, which help improve people's health and prevent the onset of diseases. The six religions all pay great attention to the aspects of diet, health, and food selection. All six religions show great interest in vegetarian foods. Within these six religions, there is a tendency for the diet to be more plant based.

However, there is a discrepancy between the results of the questionnaire analysis and the literature study. The dietary trends of Shanghai respondents with religious beliefs tends to be the same, which is increasing a balanced diet of both meat and vegetables, and reducing plant-based protein diets. In the analysis this trend also appears in religious people. This discrepancy may be due to the tendency of young adults not to be so strict on following various religious customs.

On the contrary, religious and non-religious young adults in Amsterdam hoped to consume more plantbased protein instead of animal protein. Religion does not have a great influence on the dietary choices of young adults in Amsterdam. Most religious respondents hoped to have a pure vegan diet in the future, which means no animal protein would be consumed. While most non-religious respondents wanted to have a diet with mainly plant-based protein, they indicated that few animal protein would still be consumed.

4.4 Economic condition/money

In terms of economic conditions, different income groups in Shanghai indicated a reduction in the intake of plant protein and increasing the balanced diet of animal-based and plant-based protein. Economic factors had little effect on Shanghai respondents.

The Amsterdam respondents of different income levels all showed a trend of dietary transition from animal protein to plant-based protein. The number of Amsterdam respondents in the low-income group was far exceeding those in Shanghai. This may be caused by different living standards in each country and the different definitions that had to be applied in the questionnaires accordingly.

4.5 Health

In the questionnaire, the respondents were not asked how important their health is to them, so it is impossible to analyze whether there are differences in the dietary choices of people with different health concerns. However, through literature study, both in Shanghai and Amsterdam, health is a big topic among young adults (Lonnie & Johnstone, 2020). There is a trend for people to be more concerned about their health. When they have sufficient income, they are willing to invest in their diet. Young adults are gradually realizing that eating too much animal protein products may cause danger to the human body (Manners et al., 2020).

4.6 Ranking of five forces

Except for environmental awareness, which ranked second in both Shanghai and Amsterdam, the ranking of the other four factors were completely different. For young adults in Shanghai, money factors

are the first driving force. This may be due to the pressure of living standards or other factors. For young adults in Amsterdam, health is the most important thing, as can be seen from the extremely high overall score (Table 3). This may be due to the fact that the respondents in Amsterdam generally have a high environmental awareness and pay a lot of attention to sustainable development.

In Shanghai, there is no clear preference for plant proteins or animal proteins in the diet of young adults. This may be due to the low acceptance of plant-based meat substitutes in Shanghai, since people are not familiar with them. According to the five factors, some people want more plant-based protein, while others limit the acceptance of plant-based diets. However, the vegetarian culture is slowly taking root in Shanghai. Although the Shanghai young adults are not as eager for vegan food as the young adults in Amsterdam, they do show interest in vegan food.

In Amsterdam, young adults are more eager to consume plant-based protein. The change of diet choice in young adults in Amsterdam from animal protein to plant-based protein is prevalent. The industrial chain of plantbased protein production is also well developed. The five main driving forces all have impacts on this change, but it is impossible to confirm which one is more influential.

The high acceptance of plant-based meat substitutes and high living standards are two of the reasons why these five factors are differently ranked compared to those of Shanghai.

This article presents readers the latest relationship between five driving forces and the dietary choices of young adults in Shanghai and Amsterdam. Food production and export strategies of Chinese and Dutch food companies targeting young adults need to be geared closely to the opinions of this generation group. In addition to the five presented driving forces here , there are also other forces in dietary choices for young adults which should be considered which have not been investigated in this research, such as animal welfare and trends in influential fashions. These are topics which could be investigated in future research.

5. Conclusion

Dietary protein choices by young adults are determined by different driving forces in Shanghai compared to Amsterdam. Shanghai young adults have no clear preference for plant proteins or animal proteins in the diet. The driving forces in Shanghai are ranked Money＞ Environmental awareness＞ Health＞ Culture＞ Policy. Amsterdam young adults are willing to consume plant-based protein. The driving forces in Amsterdam are ranked Health＞ Environmental awareness＞ Money＞ Policy＞ Culture. The high acceptance of plant-based meat substitutes and high living standards are two of the reasons why these five factors are differently ranked compared to those of Shanghai.

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