

# RESEARCH METHODOLOGY (SQG2613 )

## Literature Review

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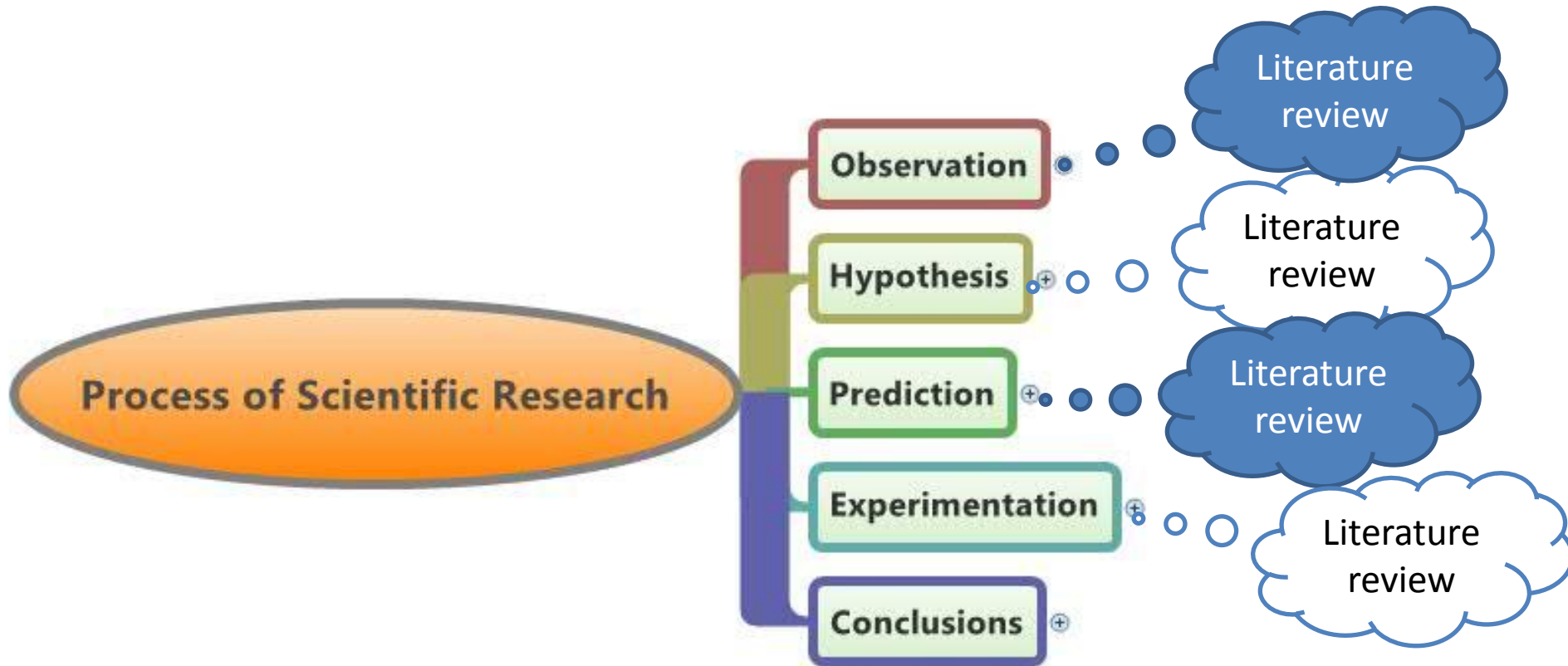
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# Literature Review



## OBSERVATION

-Obtain information-

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**-literature review-**

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**-literature review-**

## EXPERIMENT

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approach--record/  
documentation-

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## CONCLUSION

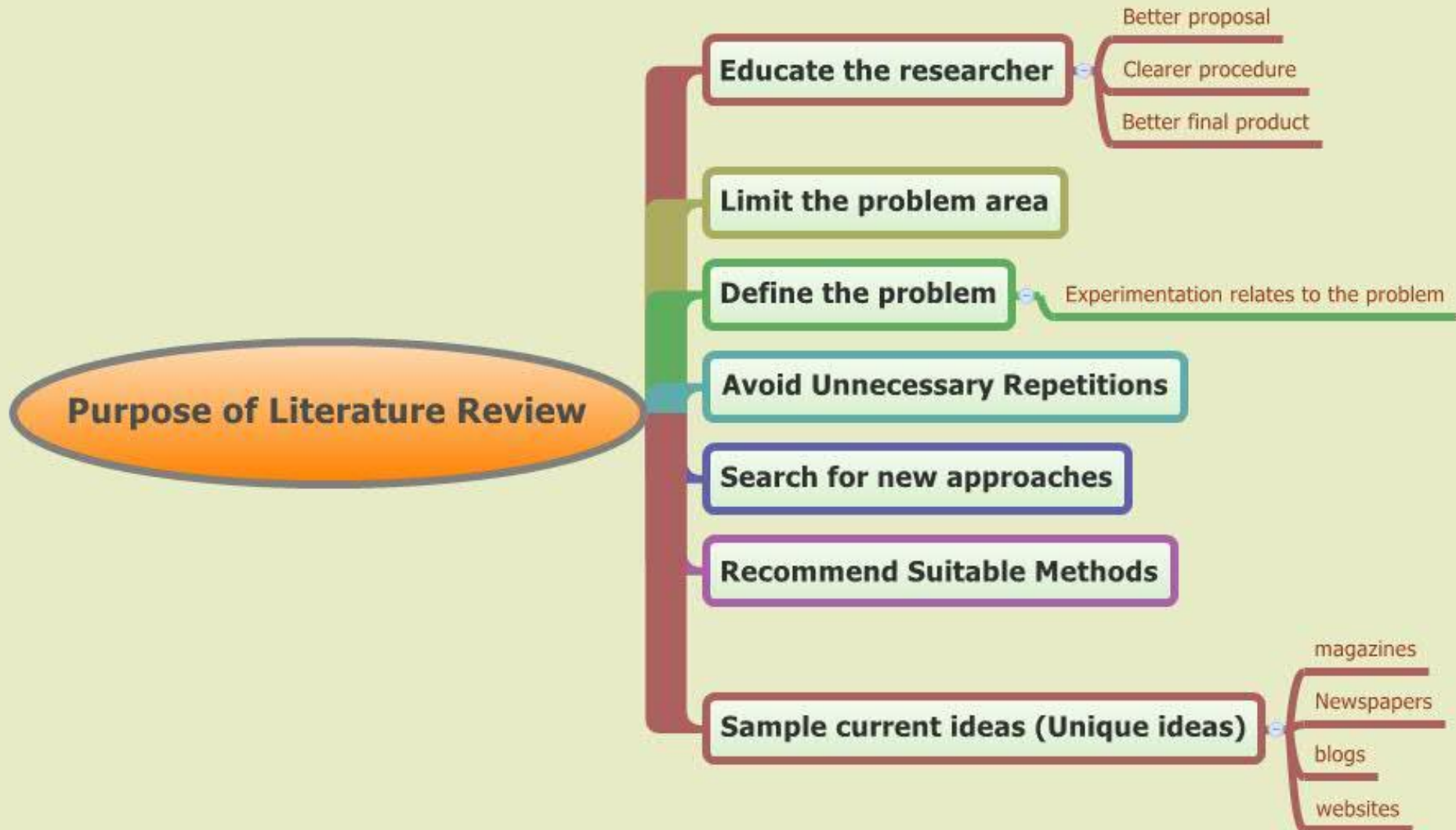
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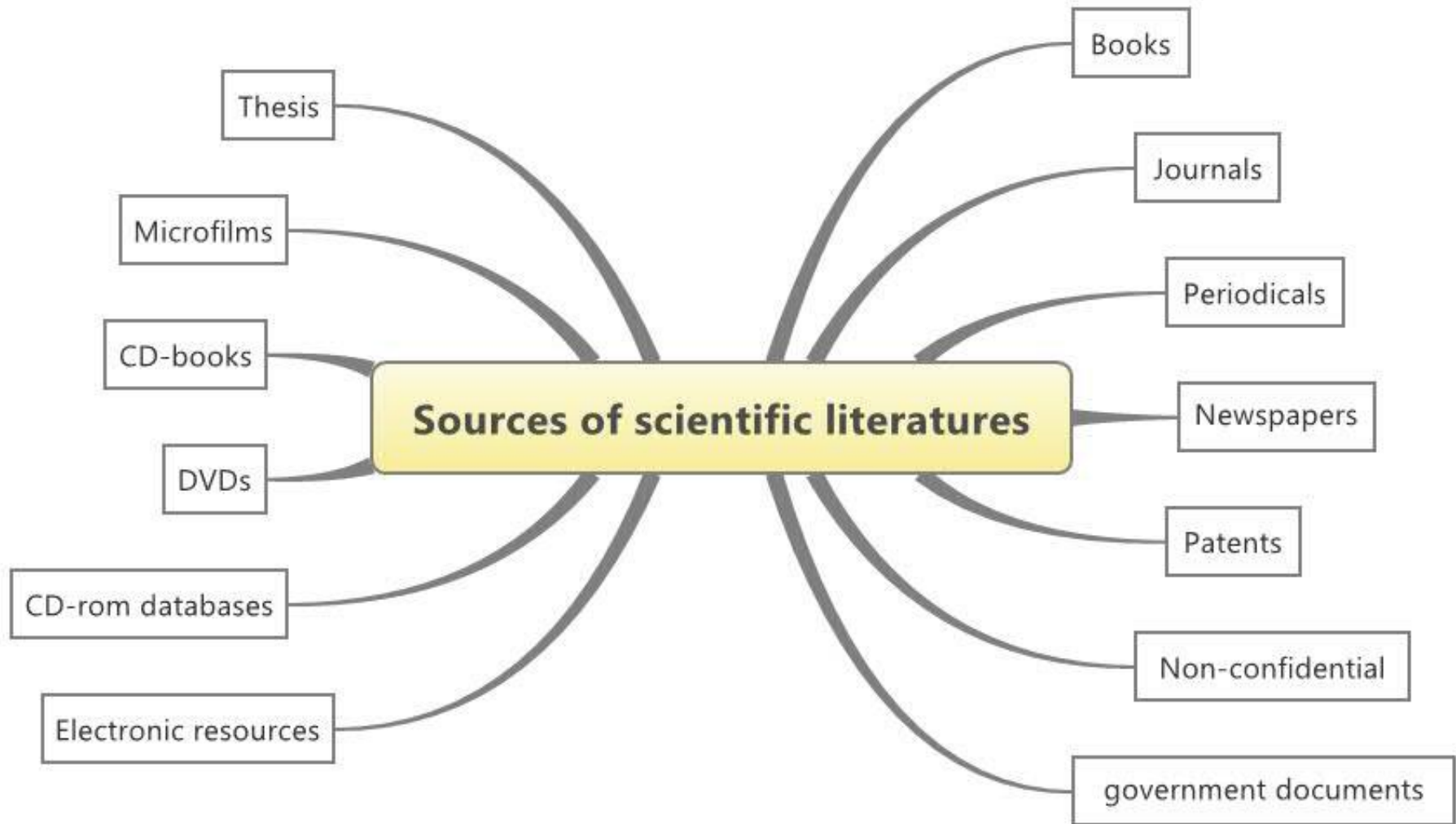
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**Learning how to use these resources properly** is equally as important as learning any laboratory techniques and other technical skill.

# Example of Scientific Journal

Journal of Hazardous Materials 162 (2009) 805–812

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## Journal of Hazardous Materials

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## Removal of Cr(VI) and As(V) from aqueous solutions by HDTMA-modified zeolite Y

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### ABSTRACT

The synthesized zeolite NaY from rice husk ash (RHA) and the commercial zeolite NaY both modified with surfactants in amounts equal to 50%, 100% and 200% of their external cation exchange capacity (ECEC) were used to remove chromate and arsenate anions from aqueous solutions. While the unmodified zeolite Y had little or no affinity for the Cr(VI) and As(V) anionic species, the surfactant-modified zeolite Y (SMZY) showed significant ability to remove of these anions from the aqueous solutions. The highest chromates and arsenates adsorption efficiency was observed from solutions of pH values 3 and 5, respectively because of the dominance of the univalent species of both anions. The adsorption equilibrium data were best fitted with the Langmuir isotherm model with the highest removal capacities observed for the SMZY initially prepared considering the hexadecyltrimethyl ammonium (HDTMA) amount equal to the 200% of the ECEC of zeolite Y. Synthesized SMZY remove Cr(VI) and As(V) more than the corresponding commercial one due to its lower silica to alumina ratio. Thus, the HDTMA-covered modified zeolite Y synthesized using RHA can be used to remove Cr(VI) and As(V) from water.

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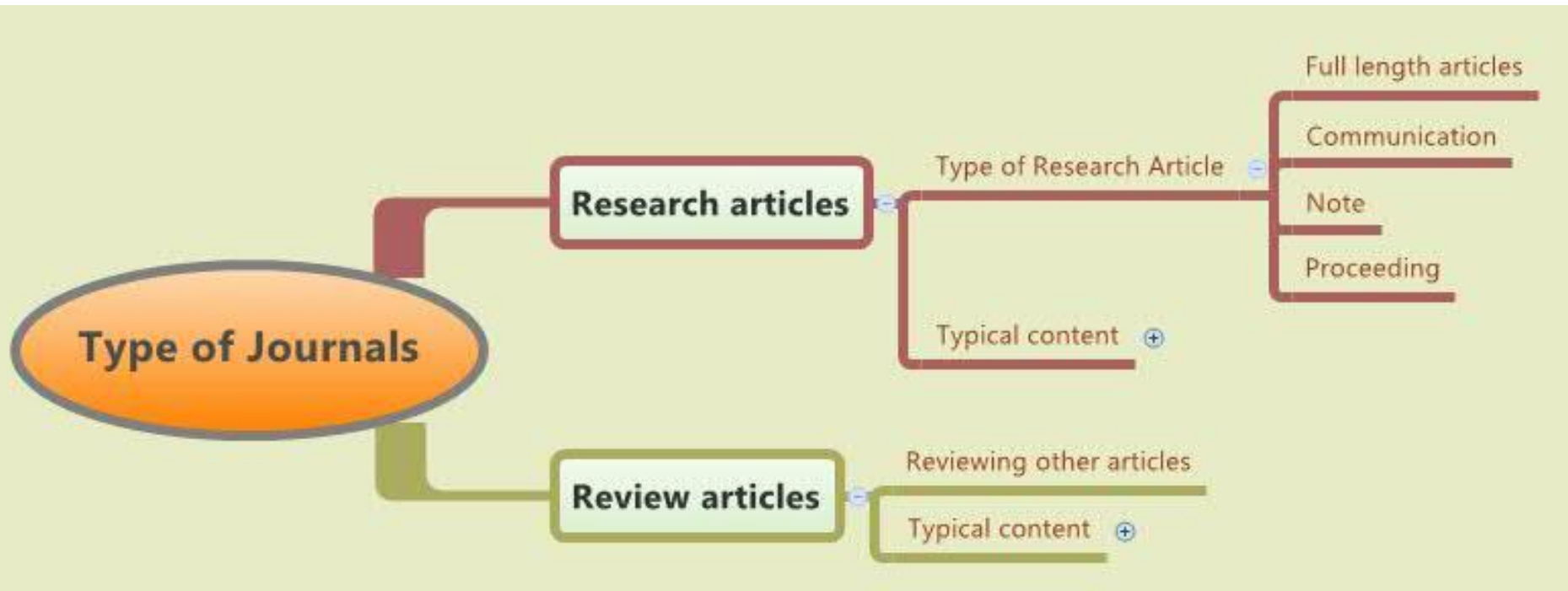
### 1. Introduction

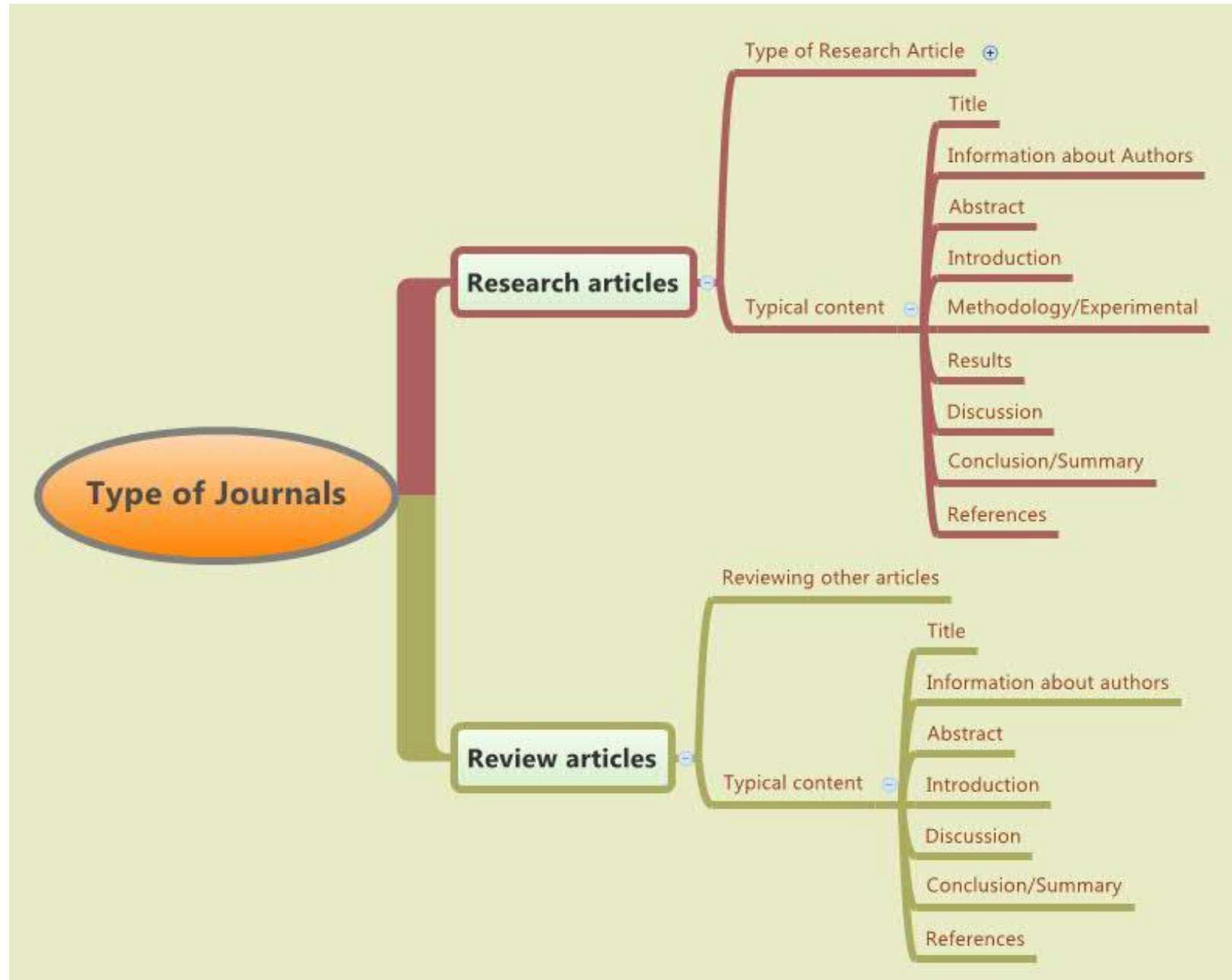
The presence of chromate [Cr(VI)] and arsenate [As(V)] anions in various sources of water are prominent issues since the toxicity of these species can result in death if these species are taken either over a long period of time or present in high concentrations. The chemical form of chromates determines their potential toxicity as Cr(VI) is believed to be carcinogenic in humans than Cr(III) species [1]. The carcinogenic and toxicity of Cr(VI) is based on its oxidation state where the chromate anion resembles the form of sulfate and chlorate [2]. Arsenate which is in the metastable

should be reduced to  $10^{-3}$  mg L<sup>-1</sup> [5]. For arsenic species, EPA adopted a new standard and public water must comply with the 0.010 mg L<sup>-1</sup> standard beginning 23 January 2006. Since Cr(VI) and As(V) are very toxic, carcinogenic and very harmful to human beings, in addition, the requirement to comply with the regulation made by the governments, the importance of removing both toxic metals in various sources before discharging them into the surface water streams or for drinking water is very crucial and critical.

In the aqueous solutions, Cr(VI) is very soluble and exists in the form of chromic acid (H<sub>2</sub>CrO<sub>4</sub>) and in the form of dichromate









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Title

Removal of Cr(VI) and As(V) from aqueous solutions by HDTMA-modified zeolite Y

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Abstract

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## ABSTRACT

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Introduction

## 1. Introduction

The presence of chromate [Cr(VI)] and arsenate [As(V)] anions in various sources of water are prominent issues since the toxicity of these species can result in death if these species are taken either over a long period of time or present in high concentrations. The chemical form of chromates determines their potential toxicity as Cr(VI) is believed to be carcinogenic in humans than Cr(III) species [1]. The carcinogenic and toxicity of Cr(VI) is based on its oxidation state where the chromate anion resembles the form of sulfate and selenate [2]. Arsenate which is in the hexavalent

should be reduced to  $10^{-1} \text{ mg L}^{-1}$  [5]. For arsenic species, EPA adopted a new standard and public water must comply with the  $0.010 \text{ mg L}^{-1}$  standard beginning 23 January 2006. Since Cr(VI) and As(V) are very toxic, carcinogenic and very harmful to human beings, in addition, the requirement to comply with the regulation made by the governments, the importance of removing both toxic metals in various sources before discharging them into the surface water streams or for drinking water is very crucial and critical.

In the aqueous solutions, Cr(VI) is very soluble and exists in the form of chromic acid ( $\text{H}_2\text{CrO}_4$ ) and in the form of dichromate.

# Elements in Scientific Journal

Methodology/  
Experimental

but ultimately, the modification of oxides by the various oxides tend to enhance the capability of adsorbent to remove arsenic species in water.

Recently the utilization of using a modifier, particularly chlorapatite modified with various oxides (CMO) with the purpose to remove multiple types of contaminants from water was studied by many researchers especially those in and transition groups (Jadhav et al. 2013). Recent study by Ganesan showed that the modification of adsorbent by strontianite-phosphorite adsorbent (STPHMA) and hexaammonium phosphate (HETMA) can remove hexavalent chromium (G). In addition, Purohit and co-workers (2015) have studied for the first time that the ability of adsorbent analysis combined with the Freundlich binding model allows them to determine of the MB binding properties for Cu(VI). Besides that, the inorganic modified natural oxides such as silicate and hematite (Si) and chlorapatite-hematite (chH) (2016) water also tend to remove arsenic from water and the results showed that the MB from chlorapatite can remove Cu(VI) more than Si(IV) (20). Although there are many papers on the utilization of natural oxides, especially chlorapatite for the preparation of MB but the synthetic oxides also can be used for the same purpose because the synthetic oxides resemble the natural oxides materials. They possess prominent negative charges on their surface and large cation exchange capacity (CEC) depending on the type of oxides allowing them to be modified by various oxides, but involves their synthesis/organic and arsenic contaminants in water.

The aim of this paper is to modify the synthesized oxides that have been used with (MB) with the various oxides adsorbent composition, namely hexaammonium phosphate adsorbent in order to enhance the capability of the material to adsorb arsenic species of Cu(VI) and Cu(V) from aqueous solutions. This study will compare the effect of the HETMA in different concentrations of treatment and compare and pH of the solution to the subsequent modification of natural oxides.

## 2. Materials and methods

### 2.1. Materials

Raw materials that have used as a source of silica to the synthesis of oxides was prepared through physical combination, the dried raw material was heated in the crucible at a constant temperature of 900 °C and constant pressure for an hour. The quantity of silica present in the MB was analyzed by Loss on Ignition (LOI) technique (NIST), silica was in the form of amorphous or porous by X-ray diffraction and field emission technology to produce it only (21).

The synthesis and its physicochemical properties of the oxides NaV were discussed in another paper (22). The physicochemical properties values of the synthesized oxides NaV (23a, NaV) and commercial oxides NaV (23a, NaV, C) are tabulated in Table 1. The commercial oxides NaV was supplied by Freuden from it used CEC (24). The procedure for the determination of natural silica ion exchange capacity (NIEC) was adopted from (25) and (26). The procedure for NIEC was used as the determination of CEC but differs in the last step in which the solution of arsenic was replaced by HETMA cation.

### 2.2. Preparation of synthesized modified oxides (F)

Three series of synthesized modified oxides F (MBF) were prepared by reacting oxides with HETMA in aqueous solution. Hexaammonium phosphate bromide (HETMA, H) was supplied by Merck (Malaysia). HETMA was added to an amount equal

**Table 1**

Physicochemical properties of 23a, 23b, F1 and 23c, NaV, C

Physicochemical properties	23a, NaV	23c, NaV, C
Initial silica (g)	11.75	11.17
SiO <sub>2</sub> (g)	11.1	10.1
SiO <sub>2</sub> (%)	11.1	11.1
SiO <sub>2</sub> (g)	11.1	11.1
SiO <sub>2</sub> (g)	11.1	11.1
SiO <sub>2</sub> (g)	11.1	11.1
Initial cation exchange capacity (IEC) (meq/g)	10.1	10.1
Final cation exchange capacity (IEC) (meq/g)	10.1	10.1
Langmuir adsorption capacity (mg/g)	10.1	10.1
Freundlich adsorption capacity (mg/g)	10.1	10.1
Initial cation exchange capacity (IEC) (meq/g)	10.1	10.1

- Data not available  
 - Data not available  
 - Data not available

to MB, MBF or MBF of IEC of oxides. This experiment was to study the effect of different such as commercial HETMA cation and the other synthesized oxides in water. The MBF was identified by a graph showing the percentage of the IEC of oxide substances especially to be accepted, followed by the determination of the type of oxides (a, b and c) for the synthesized oxides NaV and commercial oxides NaV, respectively. HETMA solution was prepared by dissolving an appropriate amount of HETMA in distilled water and was heated gently until all of HETMA, H was dissolved. After that, the HETMA solution was mixed with the oxides and the mixture was stirred using an agitator mixer for 7 days at room temperature. The mixture was then filtered by vacuum filtration and solid sample was dried at 100 °C overnight. The resultant MBF were usually used for subsequent studies.

### 2.2. Adsorption of Cu(VI)

#### 2.2.1. Effect of the pH solution

Cu(VI) solution was prepared by dissolving a suitable amount of potassium dichromate, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> (Merck, Extra pure, Cr(VI)) in distilled water. pH of the solution (10 mg/L) was adjusted with the addition of NaOH or HNO<sub>3</sub> solution to obtain pH 1, 3, 5, 7, 9 and 11 (pH of the total test was measured by pH meter CyberScan pH/Conduct/Temp/DO pH meter (Hanna Instruments)). An accurate amount of MBFV (0.2000 g) samples were mixed with the Cu(VI) solution (20 mL) in a 100 mL measuring flask. The samples were then shaken for 24 h in an orbital shaker (Hitech) and finally supernatant was filtered through a Whatman filter paper No. 1.

#### 2.2.2. Adsorbent study

Adsorbent study consisted on the aqueous solution using the batch method. In a certain amount of the synthesized and modified oxides (50 g) was placed in a conical glass beaker and added with Cu(VI) solution (20 mL) having a constant amount of Cu, V, Si, H, Al, Fe, Ni and Mn (g/L). pH of the Cu(VI) solution were kept between 1 and 2. The mixtures were shaken at room temperature at the optimal rate of 100 rpm using an orbital shaker (Hitech) for 24 h (a general choice to be sufficient to reach adsorption equilibrium). The mixture was then filtered and the filtrate was analyzed for Cu(VI) concentration by UV-vis spectrophotometry. Langmuir isotherm equation is used to determine the maximum adsorption capacity of Cu(VI) onto the MBFV.

#### 2.2.3. Determination of Cu(VI)

The value for the determination of the hexavalent chromium, Cu(VI) in the solution was based on the standard method set up by the American Public Health Association (APHA) (27). This pro-

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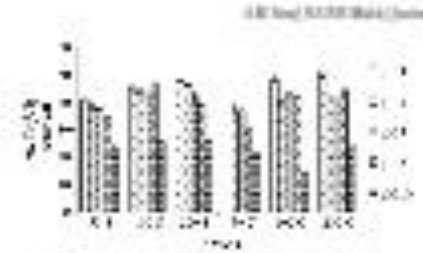


Fig. 1. Effect of pH solution on the Cu(II) adsorption by IMTY

where measured only hexavalent chromium (Cr(VI)) as when the Cr(VI) was converted automatically by the reaction with dihydroxyacetone in acid solution. The solution was transferred to a 100 mL absorption cell and the absorbance was measured at 540 nm using an ultra violet visible (UV-vis) spectrophotometer (Shimadzu, model Lambda 17) and distilled water was used as reference.

### 2.2 Adsorption of Cu(II)

#### 2.2.1 Effect of the pH solution

The stock solution of Cu(II) was prepared by dissolving 0.0250 g (0.001 mol) of a substance in a 100 mL of distilled water.

Stock 0.2 g of IMTY sample was weighed precisely and placed in the 100 mL beaker flange like. Subsequently using 0.1 mg L<sup>-1</sup> Cu(II) (10 mL) having different initial pH was added to the sample. The adjustment of the pH solution was carried out by the addition of NaOH or HNO<sub>3</sub> solution to obtain the pH 4, 5, 7, 8, 9, 10 and 11. pH was measured using a 0.1 pH/mV pH/mV 100 pH meter (Eutech Instruments). Mixtures in the beaker were shaken for 1 h at a constant agitation rate (120 rpm) and at ambient temperature. The mixture was then separated by filtration and finally, the filtrate was analyzed for the concentration of Cu(II) using flame atomic absorption spectrometry (FAAS).

#### 2.2.2 Adsorbent study

Cu(II) solution was prepared with the appropriate dilution of the stock solution to get the required concentrations of Cu(II) of between 10 and 100 mg L<sup>-1</sup>. About 0.2 g of IMTY sample was weighed precisely and added with 10 mL Cu(II) solution (pH 4) in the centrifuge tube (10 mL). The adsorbent was shaken for 1 h at the appropriate temperature. The concentration of Cu(II) before and after the adsorption were measured by FAAS.

## 1. Results and discussion

### 1.1 Adsorption of Cu(II) study

The removal of Cu(II) from water by an adsorbent is highly dependent on the pH of the solution, which subsequently affects the surface charge of the adsorbent. The degree of ionization of the species of the adsorbate species [22] is water and Cu(II) adsorbent act a single monovalent anion but after a series of the water anion depending upon the pH and the concentration of the solution. Therefore, it was important to study the effect of pH on the removal of Cu(II) using IMTY.

Fig. 1 shows the effect of pH ranging from 4 to 11 on the removal of Cu(II) by using IMTY. The removal capacity of Cu(II) by IMTY was observed to be the highest when Cu(II) solution having pH

while the lowest sorption capacity at pH 4. Similar Cu(II) removal capacity behavior from pH 4 to 11 was noted for both IMTY species and common adsorbent with different initial ion concentration of anions in the solution. The Cu(II) species might correspond to various forms such as Cu(OH)<sub>2</sub>, HCO<sub>3</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup> and H<sub>2</sub>O<sup>+</sup> in the solution phase as a function of pH. Cu(II) speciation is affected by solution pH through the following equilibrium (1):

$$HCO_3^- \rightleftharpoons CO_3^{2-} + H^+ \quad pK_1 = 6.3 \quad (1)$$

$$H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \quad pK_2 = 4.1 \quad (2)$$

$$CO_3^{2-} + H_2O \rightleftharpoons 2HCO_3^- \quad pK_3 = 3.3 \quad (3)$$

Since pH 11, the dominant species is the yellow chromate anion, CrO<sub>4</sub><sup>2-</sup>, between pH 11 and 10, HCO<sub>3</sub><sup>-</sup> and carbonate ion, CO<sub>3</sub><sup>2-</sup> are in equilibrium [20]. From Eq. (1), the major species are HCO<sub>3</sub><sup>-</sup> at pH 5 and CO<sub>3</sub><sup>2-</sup> at pH 7. Because of the distribution of Cu(II) in water which is in the form of anion, it is clearly indicated that the anion T that has been modified with calcium sulfate and an anion exchange Cu(II) species occurs successfully. The adsorption efficiency of Cu(II) was highest at pH 11 in the case of the IMTY, while the adsorption decreased below the pH increased. This is due to the dominant species of Cu(II) which exist in water and the exchange capacity of the IMTY for anion species. As described above at lower pH, the Cu(II) species are mostly in the unadsorbed form (HCO<sub>3</sub><sup>-</sup>) and this requires ion exchange rate for one molecule of Cu(II) species at that pH. In contrast, at high pH, the dissolved form of Cu(II) species (CO<sub>3</sub><sup>2-</sup>, CrO<sub>4</sub><sup>2-</sup>) are mostly present and available for ion exchange sites from IMTY for the adsorption to occur. This resulted in higher removal capacity of Cu(II) species by IMTY at lower pH than that at higher pH. In addition, the lower affinity of Cu(II) sorption at pH 11 may also be influenced by the strong competition from OH<sup>-</sup> anions on decrease sites by the anion sites since most OH<sup>-</sup> anions are present at high pH. In [10], also found similar observations at pH 11 as more OH<sup>-</sup> ions desorbed at this pH in addition, at pH values greater than 8, the presence of OH<sup>-</sup> ions forms the hydroxyl complexes of chromium. The Cu(II) species are very stable in aqueous solution and they exhibiting interaction with pH; therefore, it was possible to compare these species of IMTY in solution with pH values of 4 and 11 only.

Previous results showed that sorption of Cu(II) species by IMTY on the unmodified modified anion followed a type of Langmuir-type isotherm [24]. The Langmuir equation is based on a kinetic approach and assumes a uniform surface, a single type adsorbed material at constant temperature. The Langmuir equation is

$$q = \frac{q_m C_e}{K_f + C_e} \quad (4)$$

where  $q$  is the mass of adsorbate adsorbed (mass),  $q_m$  is the mass of adsorbate (mg) L<sup>-1</sup>, the equilibrium concentration (mass L<sup>-1</sup>),  $K_f$  is the Langmuir constant indicative of the affinity of the binding site and  $C_e$  is the equilibrium adsorption concentration (mass L<sup>-1</sup>).

Eq. (4) can be simplified to

$$\frac{1}{q} = \frac{1}{q_m} + \frac{1}{K_f q_m} C_e \quad (5)$$

Therefore

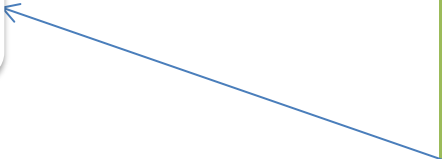
$$q = \frac{K_f C_e}{1 + K_f C_e} \quad (6)$$

The nonlinear form (Eq. (6)) can be evaluated by transforming to the linear equation:

$$\frac{1}{q} = \frac{1}{q_m} + \frac{1}{K_f q_m} C_e \quad (7)$$

where  $1/q_m$  is the y-axis and  $1/(K_f q_m)$  is the slope of the straight line graph in the case with slope is  $1/(K_f q_m)$  and intercept  $1/q_m$ . Figs. 2 and 3 show the

Results and Discussion





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1111

A.M. Yusoff, N.A.N.N. Maki / Journal of Environmental Chemistry 11 (2017) 1107–1114

## 4. Conclusions

Zeolite Y basically has little or no affinity to the anion species of Cr(VI) and As(V), but the modification of zeolite Y by the cationic surfactant (HDTMA) can enhance the adsorption capacities of Cr(VI) and As(V) on the zeolite Y. The removal capacities of Cr(VI) and As(V) on SMZY are dependent on the pH of the solution whereby the highest removal capacities for Cr(VI) and As(V) are observed at pH 3 and 8, respectively. At those pH, both species were in the univalent form which only need one exchange site from the SMZY, hence, more Cr(VI) and As(V) species can be adsorbed by the SMZY. The adsorption of Cr(VI) and As(V) on the SMZY fitted well on the Langmuir isotherm equilibrium with SMZY with HDTMA amount equal to the 100% of ECEC of zeolite Y showed the highest adsorption capacity. Surfactant-modified zeolite Y derived from the synthesized zeolite Y tend to adsorb more Cr(VI) and As(V) than the commercial one. This is due to the physicochemical properties of these zeolites where the Zeo-NaY-5 has lower silica to alumina ratio, higher CEC and ECEC as well as higher specific surface area compared to Zeo-NaY-C which creates more exchange sites for the adsorption process to occur. Thus, the synthesized zeolite NaY from rice husk ash treated with HDTMA can be used as a potential adsorbent to remove hexavalent chromium (Cr(VI)) and pentavalent arsenic (As(V)) from water.

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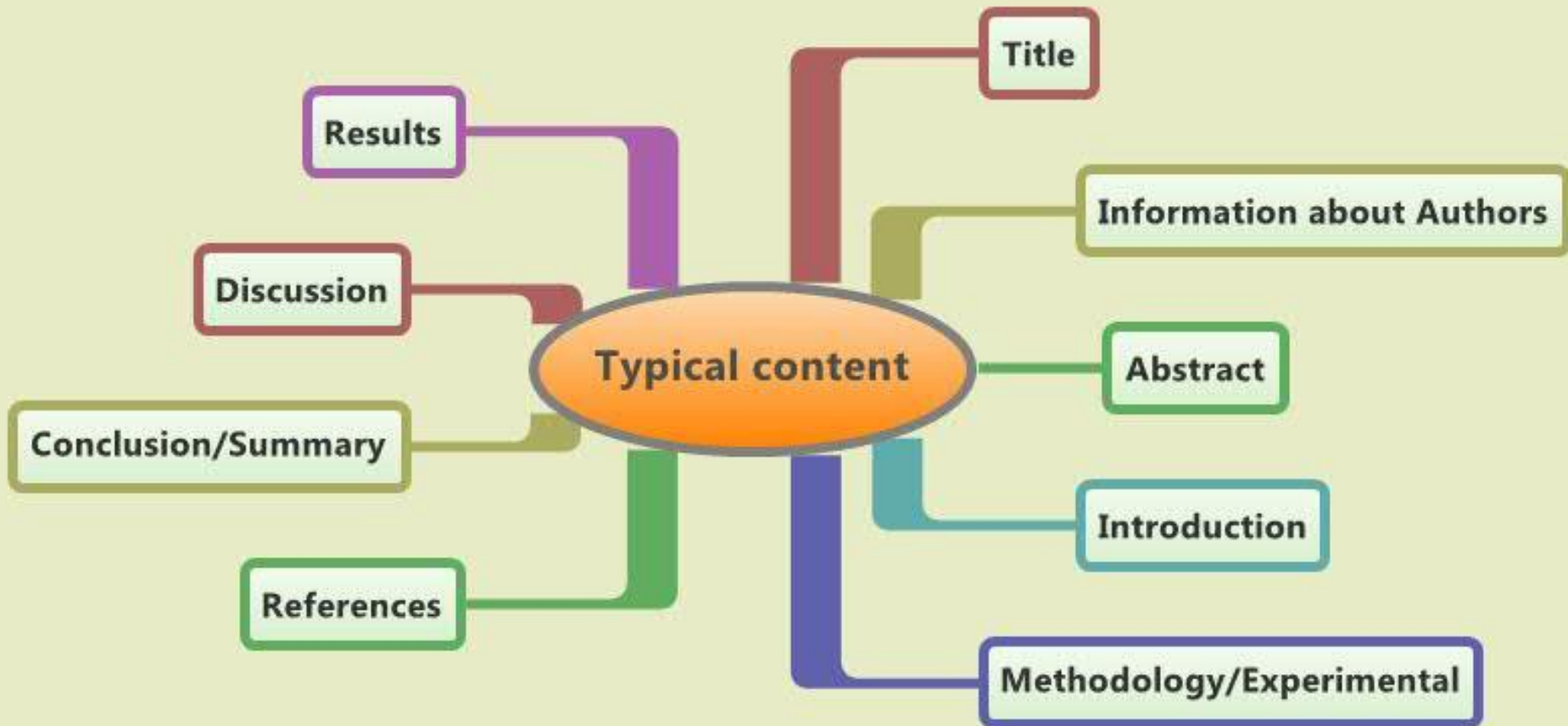
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Conclusion

References

# Information from Journals



Name of Journal


- Quality of journal
- Impact factor of journal
- Aim and scope of research area

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- Scope of overall research
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• Abstract tells about:

- Aims/objectives/goals of the paper.
- Significant method.
- Significant results.
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- Significant conclusion

## Content in Introduction

- Discussion about the problems/issues.
- Literature review – Revision of other papers reported on the same topic.
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Introduction



What you can get from this introduction:



- How author write about introduction.
- How author review related papers from other sources.
- Scientific term that author used.

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## Information about:

- Materials.
- Specific methods/procedure.
- Scientific methods/terms/units.
- Skills in writing methodology.

Methodology/  
Experimental

but ultimately, the modification of oxides by the various oxides lead to enhance the capability of adsorbent to remove arsenic species in water.

Recently the utilization of metal oxides, particularly chlorapatite modified with various oxides (CMO) with the purpose to remove multiple types of contaminants from water was studied by many researchers especially from Ni and Niobium groups (Jahid, 2013). Recent study by Ganesan showed that the modification of adsorbent by strontianhydroxyphosphate ammonium (SHSTMA) and hexaactyphosphate ammonium (HTMA) can remove hexavalent chromium (Cr(VI)) in addition to lead (Pb) and cadmium and for its studies, [12] have studied for the first time that the ability hydrothermal synthesis combined with the hydrothermal bonding could allow this for the synthesis of the MMT bonding procedure for Cr(VI). Besides that, the hydrothermal modified natural oxides such as silicate and hematite [8] and chlorapatite, hexahydroxy phosphate (Cr(VI)) water also used to remove arsenic from water and the results showed that the MMT from chlorapatite can remove Cr(VI) more than 90% [10]. Although there are many papers on the utilization of natural oxides, especially chlorapatite for the preparation of MMT but the synthetic oxides also can be used for the same purpose because the synthetic oxides resemble the natural one for materials. They possess prominent negative charges on their surface and large cation exchange capacity (CEC) depending on the type of oxides allowing them to be modified by various oxides, lead to enhance their physical/organic and arsenic contaminants in water.

The aim of this paper is to modify the synthesized oxide that from one hand with (MMA) with the various oxides and synthetic ammonium namely hexaactyphosphate ammonium in order to enhance the capability of the material to adsorb arsenic species of Cr(VI) and Cu(II) from aqueous solutions. This study was compares the effect of the HTMA in adding level, different concentrations of treatment and structure and pH of the solution for the subsequent

## 2. Materials and methods

### 2.1. Materials

Raw materials that have used as a source of silica in the synthesis of oxide was prepared through physical combination, the dried one hand was based on the combustion at a constant temperature of 900 °C and constant pressure for an hour. The quantity of silica present in the MMT was analyzed by Langmuir method (LMM) technique (NIST), silica was on the basis of phosphoryl as given by Langmuir method and silica and organology to produce it only [13].

The synthesis and its physicochemical properties of the oxide NaV were discussed in another paper [10]. The physicochemical properties values of the synthesized oxide NaV (200, NaCl) and commercial oxide NaV (200, NaCl) are tabulated in Table 1. The commercial oxide NaV was supplied by Freytag Irons & Steel (UK) [10]. The procedure for the determination of natural cation exchange capacity (CEC) was adopted from (Sudrajat, 2012). The procedure for CEC was used as the determination of CEC but differs in the last step in which the solution of one was replaced by HTMA, cation.

### 2.2. Preparation of synthesized modified oxide (Y)

Three series of synthesized modified oxide Y (MAY) were prepared by reacting oxide with HTMA in aqueous solution. Hexaactyphosphate ammonium bromide (HTMA, Br) was supplied by Merck (Indonesia). HTMA was added to an amount equal

**Table 1**

Physicochemical properties of 200, NaCl Y and 200, NaCl C

Physicochemical properties	200, NaCl Y	200, NaCl C
Surface area (m <sup>2</sup> g <sup>-1</sup> )	1170	1127
Si (wt. %)	31	32
Al (wt. %)	11	11
Ca (wt. %)	11	11
Na (wt. %)	11	11
Na <sup>+</sup>	11	11
Na <sup>+</sup> cation exchange capacity (meq 100 g <sup>-1</sup> )	100	100
Na <sup>+</sup> cation exchange capacity (meq 100 g <sup>-1</sup> )	100	100
Langmuir capacity (mg 100 g <sup>-1</sup> )	100	100
Freundlich capacity (mg 100 g <sup>-1</sup> )	100	100
Langmuir capacity (mg 100 g <sup>-1</sup> )	100	100
Freundlich capacity (mg 100 g <sup>-1</sup> )	100	100

Y = Iron oxides  
C = Iron oxide  
Y = Iron oxide

to NaV, 200 to 2000 of CEC of oxide. This experiment was to study the effect of different such as commercial HTMA and silica for the synthesis of arsenic in water. The MMT was identified by a particle counting the percentage of the CEC of oxide substance especially to be accepted, followed by the determination for the type of oxide (i.e. Y and C, for the synthesized oxide NaV and commercial oxide NaV) respectively. HTMA solution was prepared by dissolving an appropriate amount of HTMA in distilled water and was heated gently until all of HTMA, Br was dissolved. After that, the HTMA solution was mixed with the oxide and the mixture was stirred using an agitator mixer for 7 days at room temperature. The mixture was then filtered by vacuum filtration and solid sample was dried at 100 °C overnight. The resultant MMTs were finally used for adsorption studies.

### 2.2. Adsorption of Cr(VI)

#### 2.2.1. Effect of the pH solution

Cr(VI) solution was prepared by dissolving a suitable amount of potassium dichromate, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> (Merck, Exactable, Germany) in distilled water. pH of the solution (10 mg L<sup>-1</sup>) was adjusted with the addition of NaOH or HNO<sub>3</sub> solution to obtain pH 1, 3, 5, 7, 9 and 11. pH of the solution was measured by pH meter CyberScan pH/Conductivity meter (Hanna Instruments). An accurate amount of MMTY (0.2000 g) samples were mixed with the Cr(VI) solution (20 ml) in a 100 ml measuring flask. The samples were then shaken for 24 h on an orbital shaker (Hitech) and finally supernatant was filtered through a Whatman filter paper No. 1.

#### 2.2.2. Adsorbent study

Adsorbent study consisted on the aqueous solution using the batch method. In a certain amount of the synthesized and modified oxide (50 g) was placed in a controlled volume and added with Cr(VI) solution (20 ml), having a constant amount of Ni, Ni, Ni, Ni, Ni, Ni, Ni and Ni (mg L<sup>-1</sup>) pH of the Cr(VI) solution were kept between 1 and 2. The mixtures were shaken at room temperature at the optimal rate of 100 rpm using an orbital shaker (Hitech) for 24 h (a period chosen to be sufficient to reach adsorption equilibrium). The mixture was then filtered and the filtrate was analyzed for Cr(VI) concentration by UV-vis spectrophotometry. Langmuir method was used to determine the maximum adsorption capacity of Cr(VI) onto the MMTY.

#### 2.2.3. Determination of Cr(VI)

The value for the determination of the hexavalent chromium, Cr(VI) in the solution was based on the standard method set up by the American Public Health Association (APHA) [14]. This pro-

#### 4. Conclusions

Zeolite Y basically has little or no affinity to the anion species of Cr(VI) and As(V), but the modification of zeolite Y by the cationic surfactant (HDTMA) can enhance the adsorption capacities of Cr(VI) and As(V) on the zeolite Y. The removal capacities of Cr(VI) and As(V) on SMZY are dependent on the pH of the solution whereby the highest removal capacities for Cr(VI) and As(V) are observed at pH 3 and 8, respectively. At those pH, both species were in the univalent form which only need one exchange site from the SMZY, hence, more Cr(VI) and As(V) species can be adsorbed by the SMZY. The adsorption of Cr(VI) and As(V) on the SMZY fitted well on the Langmuir isotherm equilibrium with SMZY with HDTMA amount equal to the 100% of ECEC of zeolite Y showed the highest adsorption capacity. Surfactant-modified zeolite Y derived from the synthesized zeolite Y tend to adsorb more Cr(VI) and As(V) than the commercial one. This is due to the physicochemical properties of these zeolites where the Zeo-NaY-5 has lower silica to alumina ratio, higher CEC and ECEC as well as higher specific surface area compared to Zeo-NaY-C which creates more exchange sites for the adsorption process to occur. Thus, the synthesized zeolite NaY from rice husk ash treated with HDTMA can be used as a potential adsorbent to remove hexavalent chromium (Cr(VI)) and pentavalent arsenic (As(V)) from water.

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## Conclusion

- Special finding from the overall results and discussion.
- Determine the novelty of the research.



#### 4. Conclusions

Zeolite Y basically has little or no affinity to the arsenic species of Cr(VI) and As(V), but the modification of zeolite Y by the cationic surfactant (HDTMA) can enhance the adsorption capacities of Cr(VI) and As(V) on the zeolite Y. The removal capacities of Cr(VI) and As(V) on SMZY are dependent on the pH of the solution whereby the highest removal capacities for Cr(VI) and As(V) are observed at pH 3 and 8, respectively. At those pH, both species were in the univalent form which only need one exchange site from the SMZY, hence, more Cr(VI) and As(V) species can be adsorbed by the SMZY. The adsorption of Cr(VI) and As(V) on the SMZY fitted well on the Langmuir isotherm equilibrium with SMZY with HDTMA amount equal to the 100% of ECEC of zeolite Y showed the highest adsorption capacity. Surfactant-modified zeolite Y derived from the synthesized zeolite Y tend to adsorb more Cr(VI) and As(V) than the commercial one. This is due to the physicochemical properties of these zeolites where the Zeo-NaY-5 has lower silica to alumina ratio, higher CEC and ECEC as well as higher specific surface area compared to Zeo-NaY-C which creates more exchange sites for the adsorption process to occur. Thus, the synthesized zeolite NaY from rice husk ash treated with HDTMA can be used as a potential adsorbent to remove hexavalent chromium (Cr(VI)) and pentavalent arsenic (As(V)) from water.

#### Acknowledgments

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• Other papers related to this works.

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# Example of literature review

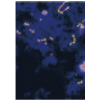
Recently, the utilization of natural zeolites, particularly clinoptilolite modified with cationic surfactant (SMZ) with the purpose to remove multiple types of contaminants from water was studied by many researchers especially from Li and Bowman groups [9,10,11,12,13]. Recent study by Campos showed that the modification of mordenite by ethylhexadecyldimethyl ammonium (EHDDMA) and hexadecyltrimethyl ammonium (HDTMA) can remove hexavalent chromium [14]. In addition, Perez Cordoves and his co-workers [15] have studied for the first time that the affinity distribution analysis combined with the Freundlich binding model allows the characterization of the SMZ binding properties for Cr(VI). Besides that, the surfactant-modified natural zeolites such as stilpnite and laumontite [16] and clinoptilolite-heulandite rich tuffs [17] were also used to remove arsenic from water and the results

# Example of Literature Review



Food Microbiology

journal homepage: [www.elsevier.com/locate/fm](http://www.elsevier.com/locate/fm)



Optimization of pressure-induced germination of *Bacillus sporothermodurans* spores in water and milk

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The germination of spores by pressure has been studied extensively for some species of *Bacillus* such as *Bacillus subtilis* (Minh et al., 2010), *Bacillus polymyxa* (Shigeta et al., 2007), *Bacillus cereus* (Opstal et al., 2004), and some species of *Clostridium* (Kalchayanand et al., 2004). Two possible mechanisms of pressure-induced germination have been described. Pressure between 50 and 400 MPa can induce spore germination through the activation of germination receptors (Pelczar et al., 2007); however, pressure above 400 MPa does not activate nutrient receptors but possibly causes the release of Ca-dipicolinic acid (DPA), which triggers the cortex-lytic enzymes (CLEs) (Paidhungat et al., 2002).

Few studies have investigated the factors affecting spore germination and inactivation with HP. For example, the pressure-induced germination spores of *B. cereus* and *B. subtilis* increase with temperature or pressure-holding time (Raso et al., 1998; Minh et al., 2010).

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# Example of Literature Review

Chemosphere

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Biodegradation of 4-aminobenzenesulfonate by *Ralstonia* sp. PBA and *Hydrogenophaga* sp. PBC isolated from textile wastewater treatment plant

Han Ming Gan<sup>a</sup>, Shafinaz Shahir<sup>b</sup>, Zaharah Ibrahim<sup>b</sup>, Adibah Yahya<sup>a,\*</sup>

## 1. Introduction

4-Aminobenzenesulfonate (4-ABS) is one of the most commonly found sulfonated aromatic amines. It is widely used as an intermediate in the production of textile dyes, sulfonamide drugs, optical brighteners and pesticides. In nature, the biodegradation of 4-ABS is problematic. Unless there is a specific transport system for 4-ABS, the negatively charged sulfonate group would prevent uptake of the substrate through the bacteria membrane (Hwang et al., 1989). Even if bacteria develop an efficient uptake mechanism for 4-ABS, the thermodynamic energy barriers exerted by both the resonance-stabilized aromatic ring and C-S bond of 4-ABS have to be overcome in order to harness energy from this compound (Wagner and Reid, 1931). Furthermore, 4-ABS could exhibit bacteriostatic activity by inhibiting the folate synthesis pathway which is crucial for the maintenance of deoxynucleotide precursors pool and DNA synthesis (Brown, 1962; Dallas et al., 1992). To date, the biodegradation of 4-ABS is still a rare occurrence in the microbial community found in natural soil, polluted

harbor sediment and even activated sludge from some wastewater treatment plants (Alexander and Lustigman, 1966; Tan et al., 2005; Yemashova and Kalyuzhnyi, 2006).

The consumption of most sulfonated aromatic amines commonly will result in the rapid excretion from organism (Greim et al., 1994). However, study in rats showed that 4-ABS has the longest retention time following ingestion as compared to its other counterparts (Honohan et al., 1979) thus making it the most significant compound to study. Under constant exposure to this compound, some negative effects of 4-ABS have been reported including hyperactivity in rats (Goldenring et al., 1982) and significant decrease in the nitrogen transformation processes in soil (Topac et al., 2009).

One of the most important sources of 4-ABS is sulfonated azo dyes. In textile industries, sulfonated azo dyes are commonly used due to its stronger binding to the fiber and lower toxicity as compared to its non-sulfonated analog. Biological treatment of textile wastewater is highly favored due to its cost-effectiveness and higher sustainability as compared to physicochemical treatment (Pearce et al., 2003). In many of the studies found in the literature, the biological treatment of textile waste involves a two-stage process: decolorization and mineralization. In the decolorization stage, an anaerobic condition is provided to stimulate reductive cleavage of azo bond by redox active compounds of bacterial origin

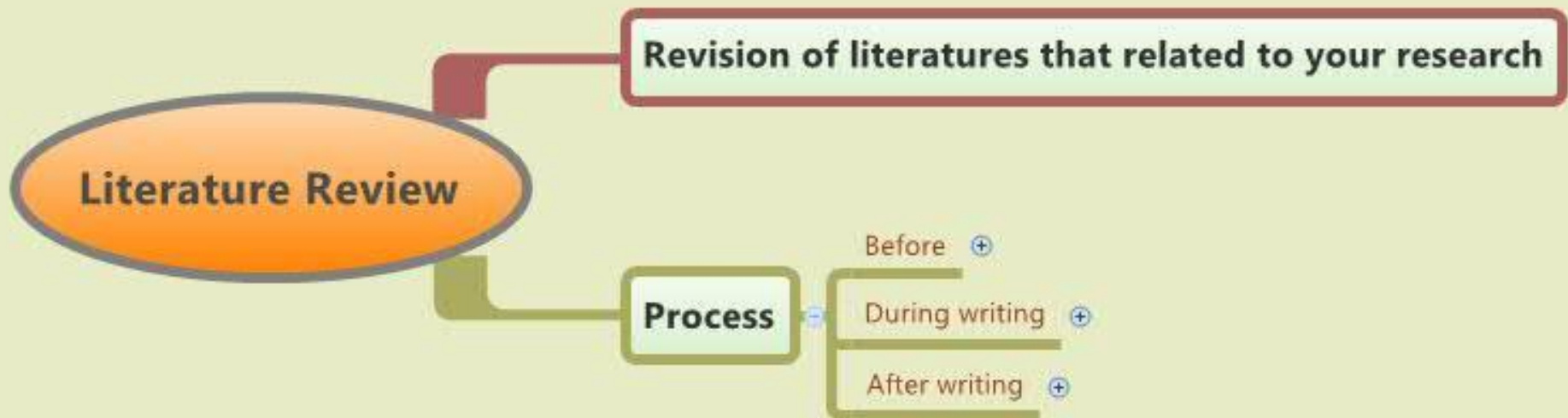
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# Literature review

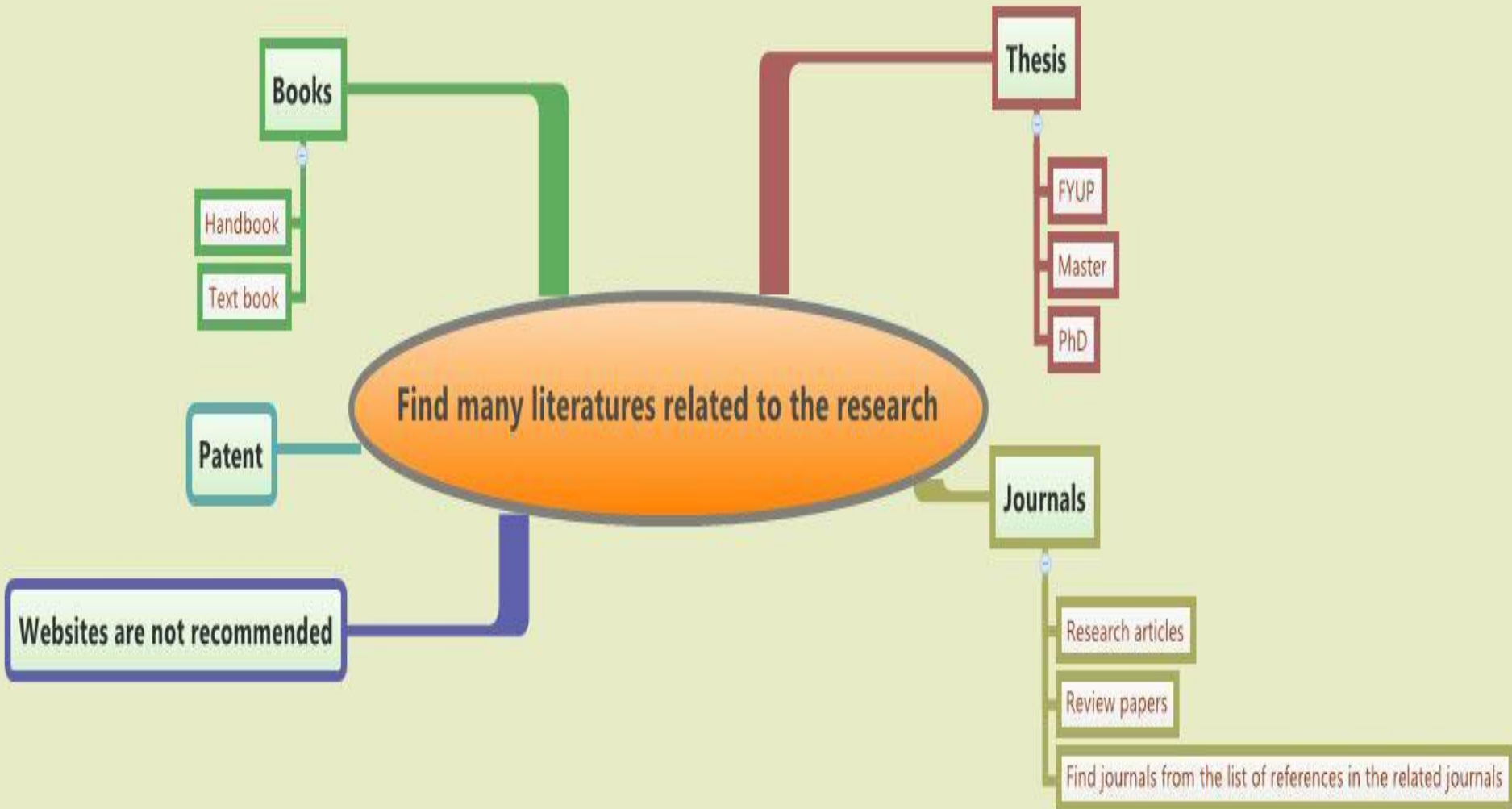
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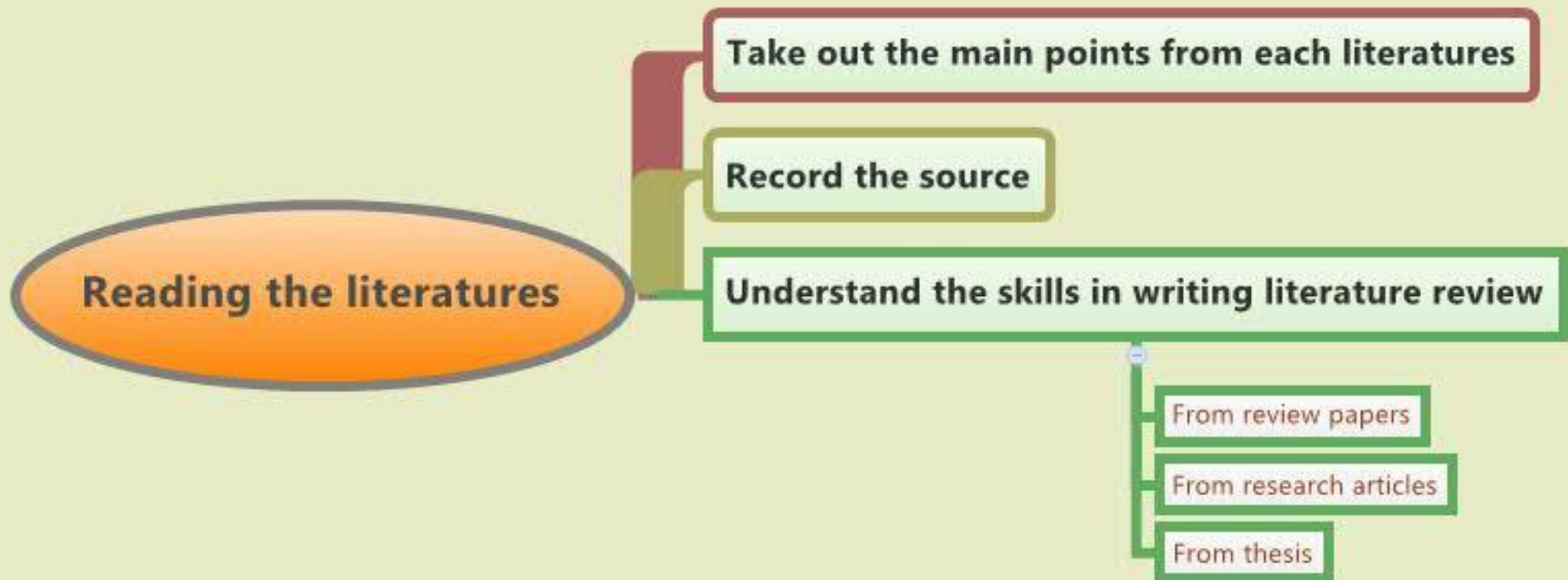




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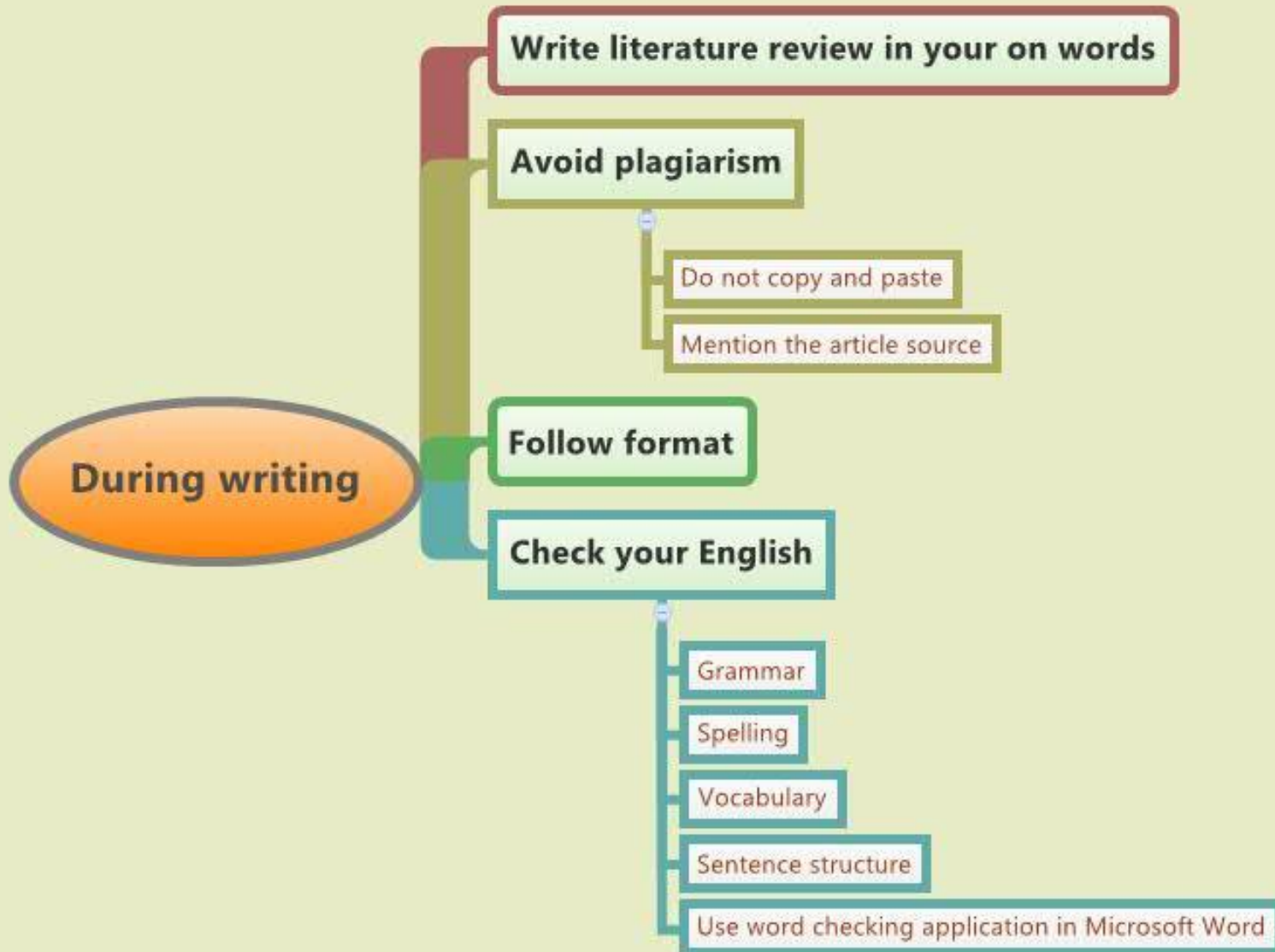
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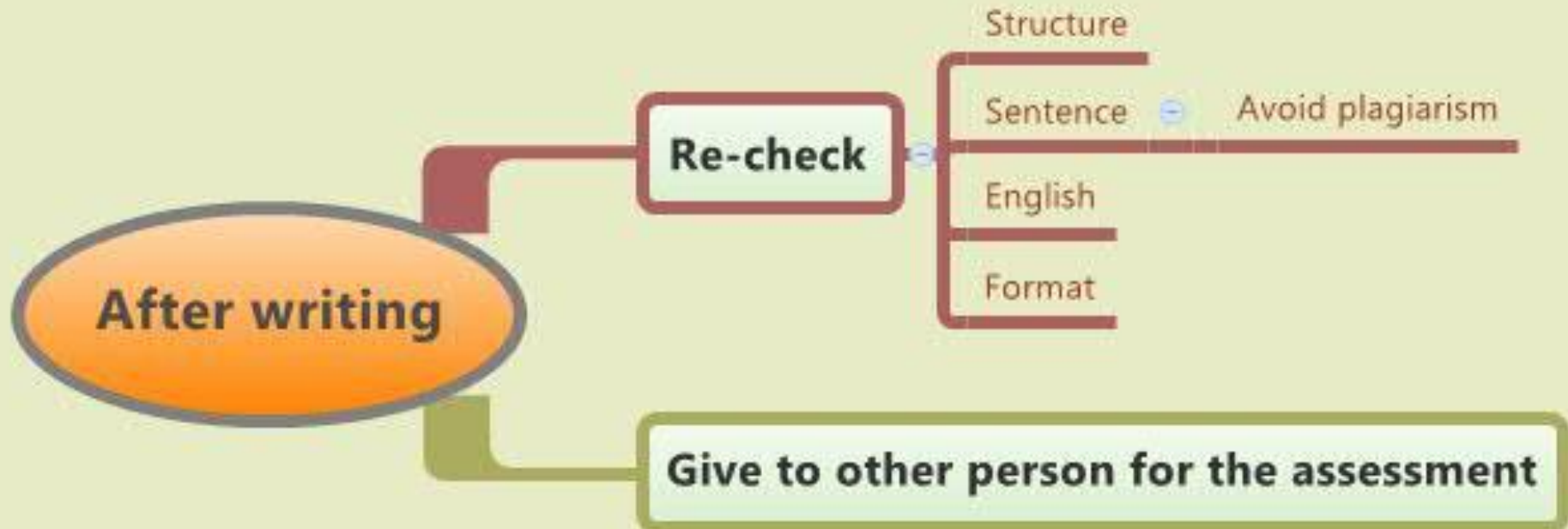
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# Literature Review – Process



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